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POSTOPERATIVE COMPLICATIONS OF CATARACT EXTRACTION

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IN A PREVIOUS paper,[1] based on a survey of 2,086 operations performed under similar conditions but with different operative technics, we compared the results of various technics used in cataract extraction. It was found that the majority of postoperative complications were related to the type of operation used rather than to the general systemic condition of the patient. Such data immediately indicated certain surgical procedures which could be expected to obviate many of the postoperative complications. In the present paper we have reviewed all these complications with the idea of determining the most effective measures for their prevention and treatment. Unfortunately, the various methods of handling postoperative complications cannot be evaluated statistically in most instances because of the multiplicity of causes and the relatively few instances of each complication.

POSTOPERATIVE COMPLICATIONS OF CATARACT EXTRACTION

Incomplete Closure of the Wound.—Delayed closure of the corneal incision was noted in 63 cases of this series, occurring most commonly when vitreous had been lost. This complication was almost completely prevented by the use of two McLean silk corneoscleral sutures.[1] The experimental use of surgical gut corneoscleral sutures has proved less satisfactory in our hands than that of silk sutures. Plain surgical gut sutures were usually absorbed soon after the fifth postoperative day,

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1. Hughes, W. F., Jr., and Owens, W. C.: Extraction of Senile Cataract: Statistical Comparison of Various Techniques and the Importance of Preoperative Survey, Am. J. Ophth. **28**:40, 1945.

and complications incident to gaping of the wound often ensued. Chromic surgical gut sutures were used in a few cases to retard absorption. However, they were difficult to place prior to the section because of their inflexibility; they produced a greater postoperative reaction and in some cases required weeks to absorb completely.

When incomplete closure of the wound occurred, the necessity of secondary operative repair depended largely on whether vitreous or capsular material had been caught in the lips of the gaping wound. Of 47 cases without protrusion of vitreous, the use of a conjunctival flap or of additional corneal sutures was necessary in only 5. On the other hand, in 12 cases in which there were exposed blebs of vitreous further operative treatment was required. In 3 of the latter, heat cauterization alone was sufficient to close a defect of less than 3 mm., but failed in 3 cases with wider gaping. In 9 cases a conjunctival flap or additional corneal sutures were required.

Prolapse of the Iris.—Prolapse of the iris occurred in 56 cases in this series. In 75 per cent of the cases the prolapse was small and well covered with conjunctiva. It is interesting to note that in 43 per cent of cases the prolapse did not occur until after the eleventh postoperative day and that in 1 case it did not appear until six months after the extraction. In these cases of late prolapse the iris was usually adherent to the posterior lip of the corneal wound at the time of the patient's discharge from the hospital.

The major etiologic factor appeared to be incomplete closure of the corneal wound. Prolapse occurred in 21 per cent of cases with gaping wounds, in contrast to 3 per cent of 2,000 cases without detectable separation of the wound. The preservation of a round pupil has often been thought to increase the likelihood of later prolapse. However, with corneoscleral sutures, the incidence of prolapse of the iris after round pupil extractions with iridotomy was the same as that after extractions combined with a full iridectomy. In the few cases of round pupil extraction without peripheral iridotomy prolapse was frequently encountered. Occasionally at operation it was difficult to reposit the iris because of the tendency of bulging vitreous to force the iris into the wound, and in such cases there seemed to be a predisposition to prolapse. Loss of vitreous at the time of operation was not a predisposing factor. The use of one, and especially two, corneoscleral sutures at operation reduced the incidence of prolapse of the iris.[1]

Small prolapses, in which a nubbin of iris, 1 to 2 mm. in size, was visible beneath an intact conjunctival flap, were frequently not repaired. In a few instances, intensive use of miotics prevented further herniation of the iris and the wound healed satisfactorily. However, all large prolapses or prolapses in which the iris tissue was not covered with conjunctiva were excised. The technical difficulties were least when the operation was performed within a few days after the prolapse had

occurred, when an intact conjunctival flap was present over the prolapse or when the corneal wound was securely closed, either with the original corneoscleral sutures or by normal healing. Corneoscleral sutures were essential in repairing the wounds if there was wide gaping, if a conjunctival flap could not be mobilized easily or if vitreous had presented.

There was no demonstrable difference in the final visual result in cases of small covered prolapses in which there was no operative intervention and those in which there was complete excision; in cases in which the wound was closed with a conjunctival flap and cases in which a corneal suture was used, and cases in which there was immediate and cases in which there was delayed repair.

Delayed Reformation and Late Loss of Anterior Chamber.—The anterior chamber was flat at some time during the postoperative course in 66 cases. In 21 per cent of these cases the anterior chamber was collapsed at the time of the first dressing; in 30 per cent the anterior chamber was formed at the first dressing but subsequently was lost. In 32 per cent the chamber was lost at the time of removal of the corneoscleral sutures, and in 17 per cent it collapsed the day after removal of the sutures.

One constant etiologic factor contributed to the delayed reformation and to late loss of the anterior chamber, namely, filtration of aqueous through the corneal incision. In the majority of the cases there was direct clinical evidence of such filtration. Gaping of the corneal incision was detected in 10.1 per cent; a filtering bleb of the conjunctiva was present in 7.2 per cent; a tear in the conjunctival flap was noted in 2.9 per cent, and loss of the chamber during or after removal of sutures occurred in 49 per cent. However, no obvious reason could be found to explain 9 cases of nonreformation of the chamber. It is probable, however, that in these 9 cases some filtration might have been taking place around a deeply placed suture tract, for the anterior chamber has frequently been found to deepen after the removal of corneoscleral sutures.

Loss of the anterior chamber following removal of corneoscleral sutures can be partially averted by precautions taken in the placement and removal of the sutures. The sutures should not be placed too deeply, but with long, superficial bites into the sclera and the corneal lips of a somewhat shelving notch. In general, such sutures should not be removed before the tenth postoperative day. In removing the sutures, adequate topical anesthesia is essential, and akinesia of the lids is sometimes necessary. The point of a sharp iris scissors should be directed away from the wound (either up or horizontally). The suture should not be grasped with forceps until it has been cut, so that the wound will not rupture if the patient unexpectedly moves his eye. A Graefe knife can be used to cut the sutures. If the sutures are deeply placed or if the patient is uncooperative, removal

of sutures should be postponed until a week or two after discharge from the hospital, when they can be removed more easily.

Treatment of a flat anterior chamber is directed toward closure of any filtering point in the wound and the use of measures to prevent peripheral anterior synechiae. Application of a pressure bandage is sometimes adequate to close a small filtering bleb. More pronounced gaping of the corneal wound or rents in the conjunctival flap may have to be repaired. In cases in which the chamber spontaneously becomes shallow after the eighth postoperative day, it is sometimes advisable to remove the corneoscleral sutures. To prevent the formation of peripheral anterior synechiae, the pupil is kept mobile by the alternate use of mild mydriatics and miotics; for the most part it is kept constricted with miotics.

Air was injected into the anterior chamber in some cases in which the chamber remained collapsed for seven to ten days. This was done by making a slanting incision with a Ziegler knife through clear cornea. Then a short 25 gage needle on a 2 cc. hypodermic syringe was inserted through this opening and sufficient air injected to reform the anterior chamber and to break up adhesions. The procedure is not without possible complications, the most important of which is a breakdown of the freshly healed incision, with hemorrhage into the anterior chamber or prolapse of the iris resulting. Accidental injection of air into the corneal stroma is of no consequence. Injection of air into the anterior chamber successfully reformed the chamber in all of the 5 cases in which it was used in this series, but peripheral anterior synechiae, visible without gonioscopic examination, persisted in 2 cases.

The formation of peripheral anterior synechiae as a result of collapsed anterior chamber is generally considered to be a predisposing factor in the production of secondary glaucoma. In 23 cases with flat anterior chambers for over seven days, secondary glaucoma ensued in 17.4 per cent, in contrast to an incidence of 4.3 per cent of 2,062 cases without prolonged absence of the anterior chamber. This difference is suggestive of an etiologic relationship, but it is not statistically significant.

Persistent Haziness of the Cornea.—It is our impression that "striate keratitis," or wrinkling of Descemet's membrane, more commonly follows the technic of intracapsular extraction with corneoscleral sutures than earlier technics of extracapsular extraction without corneoscleral sutures. Such postoperative edema of the cornea is usually transitory, disappearing within two or three weeks after operation. However, persistent corneal haziness was sufficient to reduce final vision below 20/30 in 11 cases (0.5 per cent). No single etiologic factor can be isolated, but it appears that excessive instrumentation at the time of operation, trauma in the placement of sutures, postoperative iridocyclitis and poor closure of the wound are prominent factors. These factors may lead

to such damage to the corneal endothelium and so prevent its normal regeneration that edema of the cornea persists. It is interesting that in 2 cases with Fuchs's dystrophy, 3 cases with inactive interstitial keratitis and 7 cases with other types of preoperative corneal scarring no increase in the corneal opacities followed cataract extraction. To reduce the trauma during the placement of corneoscleral sutures, 000000 braided silk on atraumatic needles [2] has been used. If the suture tract is excessively long, the suture should not be tied too tightly, or a "surgeons' knot" should be used to avoid undue wrinkling of the cornea.

Hemorrhage into the Anterior Chamber.—In this series, postoperative hemorrhage into the anterior chamber occurred in 195 cases. In 71 cases the hemorrhage either filled the anterior chamber or was recurrent. In addition, hemorrhage followed the removal of corneoscleral sutures in 3.6 per cent of 1,030 cases in which they were used. These cases have been reported elsewhere [3] and the following is a summary of these reports.

Our data support the general thesis that hemorrhage in the anterior chamber results from rupture of new-formed capillaries in the healing wound. The incidence of hemorrhages was significantly low for those extractions in which the Graefe section was placed almost in clear cornea, such wounds probably healing with less vascularization. Hemorrhages occurred least frequently when two corneoscleral sutures were used to secure firm closure of the wound. Extensive hemorrhages were more prone to occur in patients with severe or long-standing diabetes, but the height of the blood sugar was not an important factor.

Various conservative measures of treatment, such as hot or cold compresses, did not appear to influence the absorption of blood appreciably. Blood lying on the iris was absorbed more rapidly than blood either lying on capsular remains or mixed with vitreous.

The final visual results were somewhat poorer in the cases with postoperative hemorrhage in the anterior chamber, principally because of persistent opacities in the vitreous, a result of seepage of blood from the anterior chamber into the vitreous.

Expulsive Hemorrhage.—From a survey of the literature and our own 3 cases, little or no correlation is apparent between systemic hypertension and expulsive choroidal hemorrhage. Age, perhaps choroidal arteriosclerosis, and sudden reduction of intraocular tension (e. g., in eyes with glaucoma) seem to be more important factors. Attempts to reduce the blood pressure preoperatively are, therefore, not indicated.

2. These needles are manufactured by Davis & Geck, Inc., New York.

3. Hughes and Owens.[1] Owens, W. C., and Hughes, W. F., Jr.: Intraocular Hemorrhage in Cataract Extraction, Arch. Ophth. **37**:561 (May) 1947.

Iridocyclitis.—The three chief causes of postoperative iridocyclitis are (1) retained lens material, (2) rupture of the hyaloid membrane of the vitreous and (3) low grade infection.

1. Iridocyclitis Due to Retained Lens Material: In the previously reported analysis of this series,[1] postoperative iridocyclitis was found to be closely related to the amount of residual lens capsule and cortex left in the eye at operation. In 86 per cent of the 125 extracapsular extractions with iridocyclitis, the onset of the inflammation was within one month after the operation. In 5 per cent the iridocyclitis appeared for the first time after a discission, and in 2 per cent a previous iridocyclitis was reactivated by a subsequent discission. The clinical picture of postoperative iridocyclitis associated with retained lens material was nonspecific. Inflammatory changes, such as thickening and vascularization of the iris, fine keratitic precipitates, formation of posterior synechiae and cyclitic membrane and, occasionally, exudation into the anterior chamber, were most pronounced in these cases with the greatest amount

Importance of Retained Lenticular Material in Production of Ocular Changes in Postoperative Iridocyclitis

Retained Lens Material	No. of Cases	Keratitic Precipitates, %	Thickening and Vascularization of Iris, %	Synechiae and Cyclitic Membranes, %
None	16	18.8	25.0	6.3
Capsule only	32	21.8	31.2	9.3
Slight amount of cortex	19	21.0	42.0	5.3
Much cortex	24	29.2	58.3	25.0

of residual lens substances (table). Mutton fat keratitic precipitates were not ordinarily seen. Corneal edema persisted in some cases. In the few cases in which enucleation was done the nonspecific picture of subacute endophthalmitis was presented.

In a compilation of data, it was found that in the majority of cases of iridocyclitis there developed a cutaneous sensitivity to lens protein. The test for sensitization is performed by the intracutaneous injection of 0.1 cc. of a 2 per cent solution of beef lens protein. A reaction over 5 mm. in diameter after twenty-four to forty-eight hours is considered positive, and reactions of 5 to 6 Gm. are obtained in highly sensitive patients. Positive reactions may develop as early as the tenth day after extracapsular extraction. Desensitization was a valuable procedure in controlling this type of postoperative iridocyclitis; it is best carried out by Burky and Henton's method,[4] the principle being utilization of the synergistic antigenic activity of staphylococcus toxin to step up the weak antigenic activity of lens protein. The technic of such

4. Burky, E. L., and Henton, H. C.: Staphylococcus Toxin Combined with Lens Extract as a Desensitizing Agent in Individuals with a Cutaneous Sensitivity to Lens Extract, Am. J. Ophth. **19**:782, 1936.

desensitization is as follows: The dilution of staphylococcus toxin to which the patient shows a positive reaction (usually 1 : 100 to 1 : 10) is made up in a 2 per cent lens protein solution, and 0.1 cc. of this mixture is injected intracutaneously once or twice a week until no reaction is obtained. In some cases of iridocyclitis and retained lens material in which cutaneous sensitivity to lens protein was demonstrated, the therapeutic effect of desensitization with the lens protein–staphylococcus toxin mixture was striking. In other cases, the iridocyclitis cleared after surgical removal of the offending lens material.

2. Iridocyclitis Following Rupture of the Hyaloid Membrane of the Vitreous: Rupture of the hyaloid membrane at operation with presentation or loss of vitreous has been shown [1] to result in a relatively high incidence of postoperative iridocyclitis. In such cases the eye usually remained congested, and the aqueous ray persisted with few changes in the iris for two to four weeks postoperatively.

Rupture of the hyaloid face of the vitreous was often delayed several months after normal healing had occurred. This was observed in a number of patients and may be more frequent than is commonly supposed. The usual pattern of such late rupture was as follows: Several weeks or months after operation iritic pain suddenly occurred. The amount of pain was variable, sometimes being intense and sometimes being so slight that careful inquiry was needed to elicit its history. Vision became blurred, and examination with the slit lamp usually revealed low grade iritis, a ruptured hyaloid membrane and some floating iris and ciliary pigment. The iritis was usually of short duration and subsided with use of a mydriatic, such as scopolamine, with no residual damage. This late complication usually occurred after round pupil intracapsular extractions and is probably due to pinching off the bleb of vitreous which frequently projects forward like a mushroom into the anterior chamber.

3. Iridocyclitis Due to Low Grade Infection: In some of the cases of postoperative iridocyclitis without retained lens material or rupture of the hyaloid membrane the inflammatory process may be due to a low grade infection. However, it does not respond favorably to chemotherapy. Nonspecific protein therapy in the form of intravenous injections of typhoid vaccine was the most effective method of treatment. Local treatment consisted of mydriatics, hot compresses and short wave diathermy.

Secondary Glaucoma.—Glaucoma secondary to cataract extraction occurred in 87 cases in this series and was most often preceded by iridocyclitis. Of less etiologic importance were nonreformation of the anterior chamber, capsular and cortical remains or loss of vitreous.[1] In 12 of these 87 cases with secondary glaucoma normal tension was maintained over five years without operative intervention. In the

remaining cases the intraocular pressure was uncontrolled by miotics, and operation was performed in 65.

The choice of operation depends on the conditions in the anterior ocular segment which lead to the secondary rise of tension. In cases in which the angle is blocked by anterior synechiae or inflammatory debris, cyclodialysis is the operation of choice. McPherson [5] reported the results obtained in 52 such cases, finding that in 37 per cent cyclodialysis controlled the tension for at least one year, the majority of failures occurring within the first six months. Hemorrhage in the anterior chamber following cyclodialysis affected the prognosis unfavorably. Accordingly, pressure is applied over the site of the cyclodialysis immediately after rotation of the spatula, and any blood is washed out of the anterior chamber by means of the Randolph cyclodialysis instrument.[6] Since the success of cyclodialysis has been correlated by Barkan and his associates [7] with continued patency of the opening into the suprachoroidal space, the following measures are taken to promote this result: (1) selection of the site of operation in the upper quadrant if possible to avoid blocking of the angle should hemorrhage into the anterior chamber occur; (2) selection of a sector of the angle which is deepest and freest of peripheral anterior synechiae, and (3) continued use of miotics for at least several weeks after operation.

In a few cases of aphakic secondary glaucoma corneoscleral trephination was used. The results were comparable to those following cyclodialysis. This operation should probably be limited to eyes with a deep anterior chamber.

Chandler [8] has recently stressed the etiologic importance in cases of aphakic glaucoma of a block between the posterior and the anterior chamber. In these cases examination with the slit lamp reveals adhesions between the pupillary margins and the capsular remains or the intact hyaloid membrane. Because of this block, the anterior chamber becomes shallow. To relieve the block, the communication between the posterior and the anterior chamber is reestablished either by a discission or by an iridectomy.

Epithelial Downgrowth.—Intractable secondary glaucoma after cataract extraction may be caused by a downgrowth of epithelium into the anterior chamber. Only 1 enucleated eye in our series showed an epi-

5. McPherson, S. D., Jr.: Cyclodialysis in the Treatment of Glaucoma, Am. J. Ophth. **29**:848, 1946.

6. Randolph, M. E.: A New Cyclodialysis Instrument, Am. J. Ophth. **26**: 187, 1943.

7. Barkan, O.; Boyle, S. F., and Maisler, S.: Mode of Action of Cyclodialysis, Am. J. Ophth. **19**:21, 1936.

8. Chandler, P. A.: A Neglected Cause of Secondary Glaucoma in Eyes in Which the Lens Is Absent or Dislocated, Arch. Ophth. **37**:740 (June) 1947.

thelial downgrowth. This complication can be avoided by the use of a conjunctival flap of such size that its edges can be carefully sutured at an adequate distance from the corneal incision and by the use of a corneoscleral suture to insure firm closure of the corneal wound. In cases of persistent secondary glaucoma in which an epithelial downgrowth is suspected, irradiation has been used, but the effectiveness of this measure cannot be evaluated at present.

Simple Detachment of the Retina.—Retinal detachment followed cataract extraction in 31 cases of this series. The incidence of this complication progressively rose with increasing amounts of vitreous lost at the time of extraction.[1] Bagley [9] studied in detail these and 27 additional cases of retinal detachment in aphakic patients operated on at the Wilmer Ophthalmological Institute. It was found that many retinal detachments in aphakic eyes occurred long after the cataract extraction; a history of predisposing trauma was not often obtained, and detection of retinal perforation was relatively uncommon. Such evidence suggests that loss of vitreous at the time of cataract extraction may initiate degenerative changes with the formation of traction bands, which subsequently pull off the retina. Retinal detachment followed extracapsular extractions as frequently as the intracapsular type, a fact which minimizes the importance of any supporting action which the posterior lens capsule–zonule diaphragm might be considered to have. Mechanical reattachment of the retina was achieved in 35 per cent of the cases in which one or more perforating diathermy operations were performed. Factors which contributed most to the failures were (1) duration of the detachment longer than two months before operation, (2) inability to find a retinal perforation before operation and (3) failure of the retina to fall back into position after the evacuation of subretinal fluid. In the last group of cases, injection of isotonic solution of sodium chloride into the vitreous or the anterior chamber to force the elevated retina back into place resulted in improvement in the operative results. In 18 cases in which two diathermy operations had failed, further attempts at reattachment were unsuccessful.

Combined Detachment.—The patients in this series were not examined specifically to determine the incidence of combined detachment of choroid and retina after cataract extraction. However, combined detachments were usually found in eyes with a flat anterior chamber. O'Brien [10] pointed out that the combined detachment is probably the result of collapse of the chamber. Beginning subsidence of the combined detach-

9. Bagley, C.: Retinal Detachments: A Comparison of the Etiology and Results of Treatment in Phakics and Aphakics, to be published.

10. O'Brien, C. S.: Detachment of Choroid After Cataract Extraction: Clinical and Experimental Studies, with Report of Seventy-Five Cases, Arch. Ophth. **14**:527 (Oct.) 1935.

ment usually indicates an early reformation of the anterior chamber. If the anterior chamber reforms, a patient with combined detachment requires no special treatment and is discharged routinely from the hospital. All such combined detachments subside uneventfully, and there is no evidence that they predispose to simple detachment of the retina.

Purulent Endophthalmitis.—Purulent endophthalmitis occurred in 21 cases of this series. It was usually detected on the first dressing, one to four days after extraction. However, in 1 case endophthalmitis developed five weeks after the incomplete repair of a prolapsed iris, and in another, eighteen months after the cataract extraction. In 2 cases purulent endophthalmitis followed capsulotomies performed months after the cataract extraction. In cases of most violent inflammation there were edema of the lids, edema and congestion of the conjunctiva, haziness of the cornea, exudate in the anterior chamber and blurred red reflex. Cultures of the secretion in the lower cul-de-sac usually revealed hemolytic Staphylococcus aureus, but in isolated cases Staphylococcus albus, streptococci, pneumococci, Hemophilus influenzae and Escherichia coli were found. In 4 cases the infection appeared to be primary in the anterior part of the vitreous, the cornea remained clear but vision was impaired by the formation of a cyclitic membrane. Occasionally the path of the infection could be traced down the corneoscleral suture.

The most likely sources of infection in these patients were (1) obstruction of the lacrimal ducts, with resulting low grade chronic dacryocystitis; (2) inadequately treated chronic conjunctivitis; (3) sudden onset of an acute infection of the upper respiratory tract a few days after operation; (4) superficial abscesses around corneoscleral sutures, infrequently with direct extension of infection along the suture tract into the anterior chamber, and (5) undetermined causes, possibly a break in sterile technic at operation. Diabetes or the retention of lens material in the eye did not predispose to the development of purulent endophthalmitis. The following prophylactic measures have been employed for the last two and a half years, with the result that only 2 cases with purulent endophthalmitis have occurred in over 1,200 extractions. 1. The lid margins, the conjunctiva and the lacrimal sacs are carefully examined before operation for signs of chronic infection. Routine preoperative cultures were taken for several years and then abandoned because it was found that significant chronic infection was manifest clinically.[11] The significance of pathogenic staphylococci on the lid margins and conjunctiva has been emphasized by Dunnington and Locatcher-Khorazo.[12] 2. Cultures are taken in suspicious cases, and any

11. Cooper, E.: A Note on Preoperative Eye Cultures, Am. J. Ophth. **16**:850, 1935.

12. Dunnington, J. H., and Locatcher-Khorazo, D.: Value of Cultures Before Operation for Cataract, Arch. Ophth. **34**:215 (Sept.) 1945.

infection is eliminated by the local use of penicillin solution or ointment (1,000-2,500 Oxford units per gram) for a week or more before operation. At present penicillin solution is used locally at least three times during the twenty-four hours prior to operation. A 3.5 per cent tincture of iodine followed by alcohol is used for cleaning up the lids and brow. In a small series of cultures of material from the skin taken before and after operation, it was found that the iodine and alcohol were slightly better than a 1:200 tincture of nitromersol N. F. ("tincture metaphen, 1:200") and a 1:1,000 tincture of merthiolate (sodium ethylmercurithiosulfate). However, with all these substances, positive cultures were obtained from the skin of the lids after operation in over 25 per cent of cases, thus emphasizing the need to cover as much of the skin and brow as possible by careful draping. Rubber gloves are worn routinely. Sharp instruments are sterilized for forty minutes in 2 per cent saponated cresol solution U. S. P. Perhaps superior to this is the solution recommended by Post.[13] 3% Penicillin ointment is now used for dressing at the end of operation and daily thereafter, the first dressing being performed within twenty-four hours after operation. The frequent application of penicillin ointment occasionally results in sensitization to penicillin, producing edema and dermatitis of the lids. In a considerable proportion of cases in which operations were done during the period from 1939 to 1943, sulfadiazine or sulfamerazine was given orally as a prophylactic measure. From subsequent experience it appears probable that this additional measure is unnecessary.

Adequate intraocular penicillin levels are essential in the treatment of postoperative purulent endophthalmitis.[14] The highest levels of penicillin are obtained with the following methods: (*a*) subconjunctival injection of 2,500 Oxford units every four hours; (*b*) the application of cotton packs soaked in penicillin solution, 20,000 units per cubic centimeter, to the lower cul-de-sac every four hours, or (*c*) a single injection of 500 to 1,000 units into the anterior chamber or the vitreous.

The final vision following purulent endophthalmitis was poor in most cases. Prior to the days of sulfonamide therapy, all vision was lost in

13. Post, M. H., and Moor, W.: The Sterilization of Sharp Instruments by Chemical Solutions, Am. J. Ophth. **25**:579, 1942.

14. von Sallmann, L.: Penicillin and Sulfadiazine in Treatment of Experimental Intraocular Infection with Pneumococcus, Arch. Ophth. **30**:426 (Oct.) 1943; Penetration of Penicillin into the Eye: Further Studies, ibid. **34**:195 (Sept.) 1945; Penicillin Therapy of Infections of the Vitreous, ibid. **33**:455 (June) 1945. Struble, G. C., and Bellows, J. G.: Studies on the Distribution of Penicillin in the Eye and Its Clinical Application, J. A. M. A. **125**:685 (July 8) 1944. Leopold, I. H.: Intravitreal Penetration of Penicillin and Penicillin Therapy of Infections of Vitreous, Arch. Ophth. **33**:211 (March) 1945. Rycroft, B. W.: Penicillin and the Control of Deep Intraocular Infection, Brit. J. Ophth. **29**:57, 1945.

9 such cases, and enucleation was performed in 3. Of 12 patients treated systemically with sulfonamide compounds, 2 recovered 20/30 vision; 3 were able to count fingers; 3 lost all light perception, and 4 had enucleation or evisceration. One patient treated systemically with penicillin and sulfadiazine combined with subconjunctival injections of penicillin recovered 20/20 vision. A patient with an infection occurring on the tenth postoperative day failed to respond to systemic administration of sulfadiazine and injection of penicillin into the anterior chamber.

COMMENT

The present technic of cataract extraction used at the Wilmer Institute varies somewhat among individual cases, but in general it consists in the following routine: The pupil is dilated with 2 per cent homatropine hydrobromide. The orbicularis muscle of the lids is paralyzed by injection of procaine according to the Van Lint technic, or in some instances by the O'Brien block. Retrobulbar injection of 1.5 to 2.0 cc. of 2 per cent procaine hydrochloride and repeated instillations of 0.5 per cent tetracaine hydrochloride are used for local anesthesia. Occasionally general anesthesia induced with intravenous administration of sodium pentothal is used with apprehensive or uncooperative patients. The traction suture is inserted in the superior rectus muscle. A conjunctival flap about 3 to 4 mm. in size is dissected down to the limbus from 10 to 2 o'clock. A shelving horizontal groove is made halfway through the corneoscleral tissue at the base of the conjunctival flap from 11 to 1 o'clock, using a Lundsgaard knife. Two corneoscleral sutures of 000000 braided silk on an atraumatic needle [2] are inserted through these grooves according to the technic of McLean.[15] The corneal incision is usually made with a Graefe knife, but a keratome may be used. Should the suture be cut inadvertently, a complication which is surprisingly infrequent, the suture can easily be replaced. If necessary, the corneal incision can be enlarged with Castroviejo scissors. One peripheral iridotomy is made between the two sutures at 12 o'clock. The lens capsule is grasped at 6 o'clock, usually under the iris, with the Castroviejo or the Arruga intracapsular forceps. With counterpressure below, the lens is delivered by tumbling through the round pupil. The corneoscleral sutures are tied, the iris is reposited if necessary, and the conjunctival flap is restored to its normal position with silk sutures. Physostigmine salicylate, 0.25 per cent solution, is instilled, followed by penicillin ointment. A binocular dressing with protective mask is applied. The first dressing is made the following day, and the patient is allowed out of bed within twenty-four to seventy-two hours after operation. The pupil is dilated with atropine on the

15. McLean, J. M.: A New Corneo-Scleral Suture, Arch. Ophth. **23**:554 (March) 1940.

first or the second postoperative day. The corneoscleral sutures are removed on the eleventh day, and the patient is discharged the following morning.

SUMMARY

A study has been made of the causes, treatment and prognosis of complications following cataract extraction in 2,086 cases.

The complications related to insecure closure of the corneal wound, such as wide gaping with prolapse of vitreous or iris, delayed reformation of the anterior chamber and hemorrhage into the anterior chamber, are largely prevented by the use of two silk corneoscleral sutures. These complications are treated by excision of any vitreous, lens capsule or iris tissue caught in the lips of the wound, and closure by means of a conjunctival flap or additional corneoscleral sutures. If the anterior chamber does not show signs of reforming within seven to ten days, air is injected into the anterior chamber.

Postoperative iridocyclitis occurs most frequently in patients with retained lens cortex. Many of these patients acquire a hypersensitivity to the retained lens cortex and respond well to intracutaneous desensitization and operative removal of the lens material. Iridocyclitis may also follow loss of vitreous at operation or late rupture of the hyaloid membrane.

Secondary glaucoma most frequently follows postoperative iridocyclitis. In only a small fraction of cases is the tension satisfactorily controlled with miotics, in the majority operative intervention being required.

Postoperative simple detachment of the retina is usually associated with loss of a significant amount of vitreous at the time of operation. The results after perforating diathermy operations were poor if more than two months had elapsed after the onset of the detachment or if the retina failed to fall back satisfactorily after withdrawal of subretinal fluid. In cases of the latter, the injection of isotonic solution of sodium chloride into the anterior chamber to force the retina back into position greatly improved the prognosis.

Suggestions are presented for the prevention and treatment of postoperative purulent endophthalmitis.

ABSTRACT OF DISCUSSION

DR. M. HAYWARD POST, St. Louis: In the past few years, certain factors have entered the technic of cataract extraction which have resulted in pronounced changes in the relative importance of the various complications following this type of surgical intervention. The introduction of corneoscleral sutures is undoubtedly the greatest single advance in the surgical technic during this time. I have been able to achieve excellent results in several cases, in which without this safeguard the eyes would have suffered severe loss of vitreous, and probably ultimate destruction.

I prefer to use one McLean suture. The advantage of two or more is readily understood and in the hands of experts probably justifies their use, but the complications referred to by the authors undoubtedly have to be reckoned with. I am surprised at the emphasis placed on the difficulties of the removal of these stitches, for, except where the suture has been a little too deeply placed, resulting in leakage of the aqueous, they appear to be well tolerated for twelve or fourteen days, by which time their removal is much facilitated. Care should be taken to place them as superficially as possible. It is surprising what a small bite of either sclera or cornea is adequate. I have never seen a suture so placed cut out after being successfully tied, until at least ten days had passed. Use of a surgeon's knot prevents slipping and the danger of buckling of the wound. My colleagues and I have experienced comparatively few cases of phakoanaphylactic reaction among 214 extracapsular extractions performed since Oct. 1, 1944. In 1 of these, a case of my own, in which the patient was nervous and had a cardiac lesion which prohibited the use of pentothal sodium anesthesia, vitreous was expelled after the capsulotomy, so that a large part of the cortex could not be delivered. Some years ago, Dr. Burky let me have a quantity of lens extract to be used in the diagnosis and treatment of this condition, but, unfortunately, the number of such cases at that time was insufficient to make possible any definite conclusions. The present method of Dr. Burky and Dr. Henton appears to be a considerable advance in the elimination of this troublesome complication. Probably the next most important factor in changing the postoperative picture is the remarkable reduction in the frequency of infection, which has followed a better appreciation of the sources from which it arises. The almost universal wearing of rubber gloves, the use of penicillin and the sulfonamide compounds for several days before operation and the instillation of penicillin drops or ointment at the close of operation have undoubtedly played a considerable part in this fortunate result. In our clinic, the use of the sterilizing solution recommended by myself and, more recently, since Oct. 1, 1944, the care of dust-borne infection by dipping the tips of the instruments, such as Graefe knives, keratomes and forceps, into a 1 : 3,000 solution of benzal konium chloride ("zephiran chloride") immediately before use, have resulted in the almost entire elimination of septic intraocular infection in 573 consecutive cataract extractions and 263 intraocular operations for glaucoma, postcataract membranes, etc. But in 2 cases in which the procedure was omitted infections did occur after a cataract operation in 1 case and after incision of the sclera during an operation for detachment of the retina in another. The figures quoted in the authors' paper are also much smaller than was considered the irreducible minimum a few years ago. It is obvious that such a reduction in the likelihood of this dreaded complication, in conjunction with the corneoscleral suture, has permitted far greater manipulation of the eye than would previously have been considered advisable. A more meticulous toilet of the wound is possible. The iris can be carefully replaced and the tags of capsule and vitreous removed with certainty from the lips of the wound. Far greater effort, also, can be made to remove all cortex by expression and irrigation, so that the incidence of phakoanaphylactic reaction can be kept at a minimum. I am in thorough agreement with the authors, Dr. Derrick Vail and many others

that intraocular hemorrhage occurring about the fifth day, or later, arises from the lips of the wound, and that the best safeguard against this troublesome sequel lies in placing the section as far out in the cornea as is compatible with preserving the conjunctival flap. Since I have been observing this rule, my own cases have been comparatively free from this complication.

We have had no experience with the late injection of air into the anterior chamber in order to break up adhesions between the root of the iris and the corneal angle. The procedure sounds logical, provided breaking down of the wound can be avoided. It is recognized that air bubbles introduced at the time of operation are well tolerated; indeed, several of us at the McMillan Hospital have purposely permitted such bubbles to remain in the anterior chamber at the close of operation.

Dr. Frederick Allison Davis, Madison, Wis.: The authors' main thesis is based on the reduction in number and seriousness of complications which has followed certain changes in technic introduced at the Wilmer Institute during the period covered by this survey. They maintain that the general systemic condition of the patient has played a less important role than the operative technic in these results. They submit data which support the conclusion that the intracapsular method of extraction, with a round pupil, and closure of the deep wound with two corneoscleral sutures of the McLean type have been followed by the smallest number of postoperative complications and the best final results.

Unquestionably the technic employed in cataract extraction is a determining factor in a certain proportion of cases, but in my opinion the skill of the operator and the general physical status of the patient play a most important role in the final outcome. The authors have shown the favorable influence of intracapsular delivery of the lens and of two corneoscleral sutures. The incidence of incomplete closure of the wound, prolapse of iris, hemorrhage in the anterior chamber and secondary glaucoma was definitely reduced when this technic was employed. The marked reduction in postoperative iridocyclitis is noteworthy and offers a potent argument for intracapsular extraction of the lens. Since preservation of the round pupil limits loss of vitreous at operation, the complications that frequently follow this accident are thereby reduced. The authors have shown that with the use of two deep sutures the round pupil operation can now be undertaken with much greater assurance of success, since prolapse of the iris can be reduced to a minimum. My own experience has fully confirmed this observation. The value of preplaced deep sutures in limiting the amount of vitreous lost when it presents cannot be too strongly emphasized. The accurate apposition of the wound also prevents later spreading and further loss, and thereby reduces the high degree of astigmatism which so often follows this complication. The authors record delayed reformation and late loss of the chamber in 3.2 per cent of the cases. Here the favorable influence of deep suturing apparently was lost in part, since more than half these complications attended or followed removal of the sutures. Likewise, hemorrhage into the anterior chamber followed removal of the sutures in 3.6 per cent of 1,030 cases in which deep suturing was used. It seems to be a serious indictment of sutures so deeply placed that loss of the chamber and bleeding occur when they are removed. It is questionable whether the final excellent results here reported can be maintained

unless the hazard incident to the removal of the sutures can be eliminated. In my experience, a smaller and more superficial bite of the needle and the use of absorbable surgical gut sutures have prevented accidents of this type. My colleagues and I do not remove deep silk sutures before the twelfth postoperative day. If the eye is irritated or the patient uncooperative, akinesia will be found helpful in avoiding these accidents.

The authors have shown that iridocyclitis and a flat anterior chamber were the chief contributing factors in the production of secondary glaucoma. Intracapsular delivery of the lens and the use of deep sutures appear to have been mainly responsible for reducing the number of cases of this complication. In our experience, intracapsular delivery of the lens, with conjunctival sutures only, has reduced secondary glaucoma to a minimum. However, in a recent series of 350 extractions, we have had an increase in this complication following the use of the keratome-scissors method of incision combined with deep suturing. I am inclined to believe that the increase in the number and variety of complications has been chiefly due to the keratome-scissors incision rather than to the added trauma incident to the placing of deep sutures.

It would prove helpful if the authors gave us a more precise description of the technic which they now use when opening the globe.

Retinal detachment, in our experience, is infrequent after cataract extraction. In a study of 104 cases of retinal detachment at the University of Wisconsin General Hospital now in preparation by my associate, Dr. Peter A. Duehr, it is noted that 16 cases developed in a series of 1,750 extractions. Loss of vitreous was a contributing factor in but 3 cases, in 2 of which liquid vitreous followed the incision. In 13 cases vitreous was not lost at operation. Detachment occurred over periods varying from two weeks to thirteen years after operation. In 12 cases retinal detachment followed intracapsular and in 3 cases extracapsular operations, and in 1 case it developed thirteen years after needling for congenital cataract.

The increase in postoperative infections, formerly reported, which the authors attributed to deep sutures, has been materially reduced by the use of certain prophylactic measures, chief of which appears to be the local use of penicillin before operation. For more than a year we have been using penicillin ointment locally, and in many cases it has been effective in clearing the conjunctiva of bacteria and pus cells, as revealed by smears.

In spite of the excellence of the results obtained by some changes in technic of cataract extraction in recent years, one cannot but reflect on the increasing number and complexity of procedures now advanced by various surgeons. Certainly, the time consumed in placing sutures and the variety of methods now in practice for opening the globe have transformed the operation for cataract into a formidable and lengthy procedure.

DR. VICTOR CLOUGH RAMBO, Mungeli, India: Central Provinces, India, has been my working place for twenty-two years. Mungeli is 34 miles (54 kilometers) from the railroad. Persons with sick eyes have come to us there in large numbers. Last year our hospital did 2,327 operations on the eye, 1,078 of which were for the removal of cataract.

Except for the financial backing, there is no reason that the year after next we could not do 10,000 operations for cataract in and around our hospital. The blind with cataract are there. It is possible that well chosen teams sent from this country, properly financed, and knitted in with the All-India Ophthalmological Society and the missions, which are so capable in bringing blind persons into camps for ophthalmic surgery, might be the means of giving further thousands the sight for which they yearn. Chandra Kartik Dutt (Lever Action Operation for Intracapsular Extraction of Cataract, ARCH. OPHTH. **18:** 897 [Dec.] 1937) stated that though 100,000 operations for cataract are performed in India each year there are 500,000 persons in India who are blind with operable cataracts. This means that in India there are approximately 1,000,000 eyes with cataracts which the science of ophthalmology does not reach. Brigadier General Hance, now director of the India Medical Service, said to me that the number of people blind with cataract in India was closer to 1,000,000 than to the 500,000 mentioned by Dr. Dutt. In a survey of seven villages around Mungeli my colleagues and I found 1 out of 100 of the total population—men, women and children—blind with operable cataracts.

In doing such a large amount of surgical work, and in doing it almost immediately after the patients come in, we have had to adopt a strict technic. If any one came out to work with us, we should insist on certain procedures that we have found to be important: In using the speculum, we should insist that in being inserted it touch nothing but conjunctiva. It is a technical surgical error to allow the speculum to be touched by the skin beyond the edges of the lids. A sterile applicator will open the lids so that the speculum can be put in. Fingers are not used. We should insist that an instrument, an iris repositer, put into the anterior chamber and then brought out, should not be used in the eye again until it had been resterilized. So that there may be no delay, we keep duplicate instruments ready for immediate use. We have not been using gloves during operation. When we use no sutures, our hands touch no part of any instrument that touches the eye. Even gloved fingers that touch the skin of the lid cannot be considered sterile any longer. However, the statistics presented are thought provoking. We may be using gloves soon—if we can afford the extra cost and if the skill and speed lost in using gloves is not too serious a handicap. The paper by Dr. Hughes and Dr. Owens is a most helpful one. I am happy over the progress that has been made in dealing with the problem of infections and other complications of cataract extraction, which this report has brought out. Dr. Hughes and Dr. Owens have done ophthalmology a great service by presenting the routines followed which have allowed them to present this fine statistical report.

We remove 19 out of 20 cataracts through the round pupil with a tiny peripheral iridectomy. We test each pupil with homatropine before operation. If it does not dilate with homatropine, we realize that something is wrong, and we are ready to perform complete iridectomy, doing the combined extraction. But most pupils will dilate. For the Indian we find it definitely better to have a round pupil. A large pupil to face the glare of the Indian sun is not desirable. But we do not "hang ourselves on a round pupil," as one of my New York teachers recently said, and we are ready to do a combined extraction whenever necessary.

Most of our cataracts, 5 out of 7, come out intracapsularly. We use the Arruga forceps. Occasionally a cataract is found the capsule and the zonule of which will not break. This presents a real problem, demanding judgment. We must use "nonviolence." and when we find such a problem we do a capsulotomy and are glad to get out of it the best way we can, by doing an iridectomy if necessary and expressing the lens. It is in cataract surgery that the ophthalmologist has some of the most thrilling experiences. Even though he may do the cataract operation twenty-five times a day, with every cataract that is removed there is a relief and joy scarcely approached by the joy of any other procedure.

Dr. Walter B. Lancaster, Boston: One of the discussers mentioned the great variety of sutures used, and one referred to them as though one suture were the same as another. This is far from the case. Some sutures do more harm than good. Unless the suture is perfectly appositional, it prevents the lips of the wound from fitting together and does harm. To be perfectly appositional, it must be inserted in some such way as the McLean method, which seems to me to be the best. That method maintains perfect apposition, and it is rare not to have the anterior chamber reestablished at the first dressing.

The authors did not mention the matter of iridectomy. It seems to me that by far the most ideal operation demands the round pupil, and this type of extraction is easy if one uses the proper technic. However, to be sure to avoid prolapse and anterior synechia, iridectomy is needed, and that should be done in the form of a peripheral buttonhole. Wilding, of Duluth, Minn., has demonstrated how it should be done, and I can bear him out as a result of my experience. The sutures should be at 11 and 1 o'clock. That leaves spaces between 9 and 11, 11 and 1, and 1 and 3 o'clock, where iris can present and become entangled. Therefore I do an iridectomy between 9 and 11 o'clock, or at 10 o'clock, and between 1 and 3, or at 2 o'clock. These two small buttonholes are formed before the lens is extracted. The pupil has been dilated, not with atropine but with paredrine hydrobromide (para-hydroxy-alpha-methylphenylethylamine hydrobromide) or ethyl amino-benzoate, aided with cocaine and epinephrine, so that the pupil is well dilated. The lens is extracted through the dilated pupil. The two sutures are tied, or perhaps only one tied, and then a third iridectomy is done at 12 o'clock. If that iridectomy is done before the extraction, it is quite possible to have the lens catch in the opening. Therefore, it is better to do the last iridectomy after the lens is extracted and when one or both sutures are tied.

Dr. William F. Hughes Jr., Chicago: It is encouraging to hear that further experiences with these newer technics in various parts of the country are found to eliminate many of the serious complications resulting from insecure closure of the wound and retention of lens material. With use of two corneoscleral sutures and a relatively shallow section toward the corneal side, the anterior chamber is practically always formed again after twenty-four hours. The incidence of prolapse of the iris and the vitreous is much reduced, and spontaneous hemorrhages in the anterior chamber have become unusual. As Dr. Davis has pointed out, however, the use of corneoscleral sutures is not an unmixed bless-

ing, but we believe that the difficulties associated with their use are of a less serious nature and can largely be prevented if special precautions are taken in the placement and removal of the sutures. These precautions correspond in almost every exact detail with those which Dr. Post has enumerated. They include more care in the prevention of infection. The two McLean silk corneoscleral sutures are inserted by first dissecting a conjunctival flap as far down on to the limbus as possible. A notch, slanting about 45 degrees toward the corneal side, is then made about halfway through the cornea at the base of the conjunctival flap. The corneoscleral sutures are then inserted at 11 and at 1 o'clock, first up through the base of the conjunctival flap, then back, with relatively long bites in the scleral and corneal lips of the notch. The sutures should be left in place at least ten or twelve days, and preferably two or three weeks, before they are removed, so that the wound is well healed and will not rupture or result in a hemorrhage in the anterior chamber. The retention of a round pupil is accomplished with one peripheral iridotomy at 12 o'clock between the two corneoscleral sutures. Preservation of a round pupil is probably of less importance, although it gives a beautiful cosmetic result, reduces glare and in all probability reduces the incidence of loss of vitreous at operation.

We feel strongly that postoperative iridocyclitis, particularly that following retention of lens material, is one of the most serious complications of cataract extraction, frequently leading to secondary glaucoma or cyclitic membranes. The possibility of sensitivity to lens protein should be investigated in these cases, and if necessary, desensitization should be performed with lens protein–Staphylococcus toxin mixture, combined with operative removal of any residual lens cortex.

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MACULAR HOLE WITH EXTENSIVE PERIPHERAL DETACHMENT OF RETINA

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TWO AUTHORS described hole formation in the macular area of the retina independently of each other at about the same time —Haab,[1] in Switzerland, and Ogilvie,[2] in England. In this connection, it is interesting to note that in the same number of the *Zeitschrift* [1] in which the work of Haab appeared Kuhnt [3] described the same entity; he did not designate it as hole formation, but called attention to peculiar macular changes in the retina (retinitis atrophicans sive rareficans centralis). This difference in definition may be responsible for Kuhnt's observation frequently going unnoticed, hole formation in the macula remaining linked to the names of Haab and Ogilvie. Haab's review of the previous literature revealed 3 cases (Hoffmann,[4] Hartridge [5] and Lawford [6]) with similar pathologic changes which probably fitted into the group of his cases; all had in common a traumatic origin and, to a greater or less degree, the characteristics of hole formation.

Haab had already recognized that the clinical picture in his 12 cases represented hole formation in the macula. The history revealed a traumatic origin in only 9 of his series; in the other 3 instances there was no history of blunt injury representing concussion and therefore, by exclusion, the spontaneous origin was at once evident. The cumulative results of observation in the following years proved that the hole formation may occur spontaneously, without any trauma; nevertheless, considering that the greater majority of his cases had a traumatic basis, Haab left undecided the nontraumatic origin of hole formation.

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1. Haab, O.: Die traumatische Durchlöchrung der Macula, Ztschr. f. Augenh. **3**:113, 1900.

2. Ogilvie, F. M.: "Holes at the Macula": A Result of Injury to the Eye by Concussion, Ophth. Rev. **19**:232, 1900.

3. Kuhnt, H.: Ueber eine eigentümliche Veränderung der Netzhaut in Macula (Retinitis atrophicans sive rareficans centralis), Ztschr. f. Augenh. **3**:103, 1900.

4. Hoffmann, F. W.: Embolie eines Astes der Arteria centralis retinae mit hämorrhagischem Infarkte, Klin. Monatsbl. f. Augenh. **23**:24, 1885.

5. Hartridge, G.: Peculiar Appearance of the Macula, Tr. Ophth. Soc. U. Kingdom **9**:144, 1889.

6. Lawford, J. B.: Peculiar Changes in the Macular Region, Possibly Traumatic in Origin, Tr. Ophth. Soc. U. Kingdom **13**:76, 1893.

According to Haab, the hole is about one-half the diameter of the disk, red and round; the differentiation from the adjoining retina varies, depending on the cloudiness of the latter. The retina surrounding the red disk frequently exhibits delicate gray dots or lines. Against the red background of the hole are small, more or less numerous white or yellowish dots or patches with intermingled brownish spots. The hole formation in the red spot is proved by parallax and the slight difference in refraction between the margin and the bottom in a manner similar to that in which the depth of cupping of the disk is measured. The relatively larger size of the red spot, together with the sharp, round margin, differentiates it from the red spot visible in cases of occlusion of the central artery. The bright red color of the spot depends on the direct view of the underlying, exposed choroid, with the intact layer of pigment epithelium; ophthalmoscopically, the red color is similar to that familiar in fresh retinal tears and in holes of the detached retina. The dots at the bottom of the hole represent remnants of retinal tissue and, according to their number and shape, show a wide range of variation in the course of development in the same case, or possibly they may be accumulations of wandering cells. Central visual acuity is always greatly diminished, and a large central scotoma is noted in all cases. The typical circular form may change to oval through shrinking of the adjoining parts of the retina as a result either of fibrinous deposits on the surface or of degeneration of connective tissue. The hole itself is framed with a narrow gray ring of cloudy retina, the appearance recalling the cloudy area in cases of arterial occlusion, but the cloudiness is always of a much slighter degree. Haab noted spontaneous hole formation due to necrosis associated in a flat detachment of the central portion of the retina.

Ogilvie observed 15 cases of macular hole. He described the lesion as a deep punctured hole, generally circular or oval, as though the macula had been trephined out; he stated that the diameter is about one-half or one-third that of the optic disk. The area is depressed and bright red, with clearcut edges, the depth of the hole averaging 1.5 D. He compared the lesion to a hole broken in thin ice. The floor of the red area is peppered with fine pigment dots. Remnants of the retina remain as granules on the exposed choroid, whereas the edges and other portions curl up and are hidden behind the edges of the hole. The surrounding pleats and folds represent edema of the retina and accordingly disappear after a time. Anatomic evidence that the hole formation is due to force applied by a blunt instrument is given by the fact that the foveola itself is the thinnest part (0.1 mm.) of the retina and the edges are the thickest (0.49 to 0.50 mm.) and the structures sharply change from thickest to thinnest as one passes from the edges to the central, thin depression. The 15 cases of hole

formation observed by Ogilvie formed two distinct groups; cases with and cases without retinal detachment. In the cases the detachment differs from the usual type, the retina remaining transparent and the detachment showing no tendency to increase, even after the lapse of considerable time; the detachment is usually shallow and extends over a large area. Degenerative changes, frequent with other types of old detachments, do not develop. Ogilvie's clinical description is so complete that almost nothing is omitted. The conclusion, however, that the hole formation represents only a traumatic lesion, and that no other cause may contribute to it, cannot be maintained in view of the present knowledge concerning spontaneous, nontraumatic hole formation.

Kuhnt's study was based on 4 cases, 1 of traumatic and 3 of spontaneous origin; his description of the ophthalmoscopic picture is similar to that of Haab and Ogilvie. The shade of the red spot showed slight variation, corresponding to the pigmentation of the choroid and pigment epithelium, but in all cases the color appeared to be more saturated than that of the fundus. The depth of the depression measured 0.75 to —1.0 D. The granular appearance of the floor depended on the presence of vascular loops in the choriocapillaris and the peculiarities of the epithelial layer. Hole formation of traumatic origin is produced through softening of the avascular central portion of the retina; the holes of spontaneous origin result from retinitis of the posterior pole, leading to atrophy of the central portion of the retina. Kuhnt emphasized that the changes included only the retina, whereas the choroid presented no visible pathologic signs, even after years, a characteristic which differentiates hole formation in the macula from the senile circulatory changes, the latter being known to involve the choroid, if not all layers, at least the choriocapillaris and the layer of small vessels.

The entire question of hole formation in the macula was given a scholarly and thorough consideration by Duke-Elder,[7] who quoted H. Knapp and Noyes as the first observers of isolated cases of this lesion. The most common cause is trauma, such as contusion injuries of the globe or retention of foreign bodies. Ogilvie assumed a contrecoup mechanism, which accounts for the cases in which hole formation occurs immediately after a severe blow to the anterior segment but is not adequate to explain the cases in which the hole results from a laterally directed blow or considerable time elapses between injury and hole formation. In cases of the last type the mechanism consists in cystic degeneration of the avascular central area with rupture of the cystic walls. In the cases of nontraumatic origin the etiologic agent is either degenerative (senile or cardiovascular) or toxic (toxins of the vitreous derived from an inflammatory process in the anterior segment).

7. Duke-Elder, S. W.: Text-Book of Ophthalmology, St. Louis, C. V. Mosby Company, 1941, vol. 3.

Macular hole is not invariably associated with detachment of the retina; thus, in a series of 23 cases Middleton found only 1 case of detachment. Duke-Elder stressed that peripheral retinal holes are usually associated with large and extensive detachments, the macular holes causing only limited and nonprogressive retinal separation.

Discovery of peripheral holes in cases of detached retina preceded that of the macular holes. Peripheral holes were noted by Coccius (1853) and von Graefe (1863), and later de Wecker drew attention to their striking frequency of association with detachment in myopic eyes (1870). De Wecker, Martin and le Lucca employed ignipuncture as a therapeutic measure, and Schöler expressed the belief that closure of the retinal rent is the logical remedy for the condition. Still, the isolated cases of closure of the hole remained unrecognized and unappreciated. Finally, the dramatic therapeutic results of Gonin focused attention on the importance of hole formation in the pathology of retinal detachment and led subsequently to appreciation of the fact that closure of the hole or tear is of extreme importance. Gonin's work centered attention on search for the holes, and their presence was noted in ever increasing numbers. Additional data were accumulated on the frequency of retinal dehiscences in cases of peripheral detachment and the relative infrequency of detachment with macular holes; the latter circumstance lacks a proper explanation. Vogt [8] mentioned 3 cases of macular hole with detachment; Arruga,[9] 6 in a series of 132 cases of detachment; Meisner,[10] 5 in a series of 90 (3 without peripheral holes), and Schmidt,[11] 9 in a series of 200 cases; Stein [12] referred to 6 cases, and Prevec,[13] and similarly Weve,[14] reported 4 cases.

Vogt's first case was that of a woman aged 25, with myopia of 28 D. The macular hole was very small, with the cover toward the disk, the

8. Vogt, A.: Operative Therapie und die Pathogenese der Netzhautablösung, Stuttgart, F. Enke, 1936; 6 Monate alte Netzhautablösung, entstanden durch isolierten Maculaloch, Verschluss des Loches durch Katholysen- und Diethermiestichelung, Klin. Monatsbl. f. Augenh. **100**:130, 1938.

9. Arruga, H.: The Detachment of the Retina, translated by R. Castroviejo, New York, B. Westermann, 1936.

10. Meisner, W.: Das Maculaloch bei der Amotio retinae, Klin. Monatsbl. f. Augenh. **98**:379, 1937; Zum Vorkommen und zur Entstehung der Netzhautablösung, ibid. **97**:289, 1936.

11. Schmidt, R.: Ueber Lochbildung in der Netzhautmitte, Klin. Monatsbl. f. Augenh. **102**:788, 1939.

12. Stein, R.: Zur operativen Therapie der Netzhautablösungen mit macularen oder maculanahen Netzhautlöchern, Klin. Monatsbl. f. Augenh. **98**:395 and 402, 1937.

13. Prevec, S.: Ueber einige länger beobachtete Fälle von centralen Netzhautablösungen, Klin. Monatsbl. f. Augenh. **97**:289, 1936.

14. Weve, H.: Die Heilung durch Fovealöcher verursachter Netzhautablösung mittels Diathermie, Arch. f. Augenh. **109**:534, 1936.

width being equal to that of a central vein (the picture shows the hole to be pinhead in size, as compared with the disk); the detachment was extensive, with many folds, saclike in the temporal region and beginning at and including the macula; no tear was noted in the periphery. In his second case, that of a woman aged 62, there was a refractive error of +2.0 D., with a horizontal oval hole in the macula, the greatest diameter corresponding to one-half that of the disk. The hole was the result of cystic degeneration of long standing; the adjoining retina showed a flat detachment. In both cases catholysis was employed. In the first case two sittings resulted in good vision; in the second case twenty catholytic punctures were employed. After the operation vision was improved; the hole was still visible; only the margins were turned toward the choroid, with scarification of the adjoining retina and one pigment patch between the macula and the disk. Vogt described another case of retinal hole with detachment in which operation was not performed; both eyes showed excessive myopia, and in the left eye an extremely small punctate hole was observed, with extensive detachment of the temporal part of the retina. In the early period the detachment was flat and central; later, extension into the periphery with folding developed, without the presence of a peripheral tear.

In Schmidt's series, of 14 cases of macular hole, 6 were due to trauma. In 4 cases the eyes were myopic; in 3, hypermetropic, and in 7, emmetropic. Of the 8 cases of spontaneous origin choroiditis was present in 2, periphlebitis in 2 and high myopia in 3; in 1 case there were macular hole with cystic changes in the surrounding retina and macular degeneration in the fellow eye. Of 14 cases of macular hole, 5 presented no detachment; 4, a small ring-shaped detachment of the area around the hole but not extending over the fovea, and 5, extensive detachment (in 1 case almost total detachment followed unsuccessful operative intervention). In the majority of cases perimacular detachment proved to be stationary, and not progressive; in 1 (case 9) spontaneous reattachment of the perimacular separation even occurred; in the 4 cases of macular hole without detachment the process did not develop further in the course of longer observation.

In the 4 cases reported by Prevec the eyes were hypermetropic, and therefore the macular holes were classified on the basis of senile degeneration. In 1 case there was cystic degeneration of the macula of the sound eye; in his second case the hole was the direct result of previous macular degeneration. In 2 cases macular hole developed in the wake of cystic degeneration with central detachment without the presence of any traction on the part of the vitreous, which may be an additional factor in the production of peripheral tears and detachments. In the first case, that of a woman aged 68, a macular hole was surrounded by cystic degeneration; the hole was round and of one-third disk diam-

eter, and in red-free light a yellow coloration of the peripheral parts was discernible. The hole was surrounded by a flat detachment, of horizontal oval form and measuring 3 or 4 disk diameters. Six punctures with a cathode needle was followed by a complete reattachment, as observed after five months. The second case was that of a man aged 63, with posterior detachment of the vitreous, cystic degeneration of the macula and three large central cysts with a wreath of small ones; two weeks later a fresh detachment, of 4 disk diameters, appeared at the posterior pole. Of the three central cysts, two lost their anterior limiting walls, resulting in a double hole in a cystic floor; red-free light revealed the presence of holes. In the further course of development, the wall of the third cyst disappeared; the resulting hole was almost circular, and the detachment simultaneously expanded. Later observation showed that the circular outline of the hole changed first to a vertical oval; the later shrinking was responsible for scalloping of the margins, with further expansion of the retinal separation. The hole gradually diminished in size, to be followed by complete spontaneous closure, folding and, finally, complete spontaneous reattachment of the retina. In the third case, that of a man aged 72, a cataract in the left eye had been extracted one year previously; there was a round macular hole measuring ⅓ disk diameter (senile macular degeneration of the other eye) with a flat circular detachment of 3 disk diameters. At the end of eight months the hole had become decidedly larger and the detachment remained unchanged. In his fourth case, that of a woman aged 77, a small cyst without hole formation was first noted in one eye and a slight degree of macular degeneration with dislocation of pigment in the other eye. Examination four weeks later disclosed a small round hole in the first eye with fresh detachment of a few disk diameters at the posterior pole; both disappeared spontaneously within six months, leaving visible only dislocation of pigment in the area.

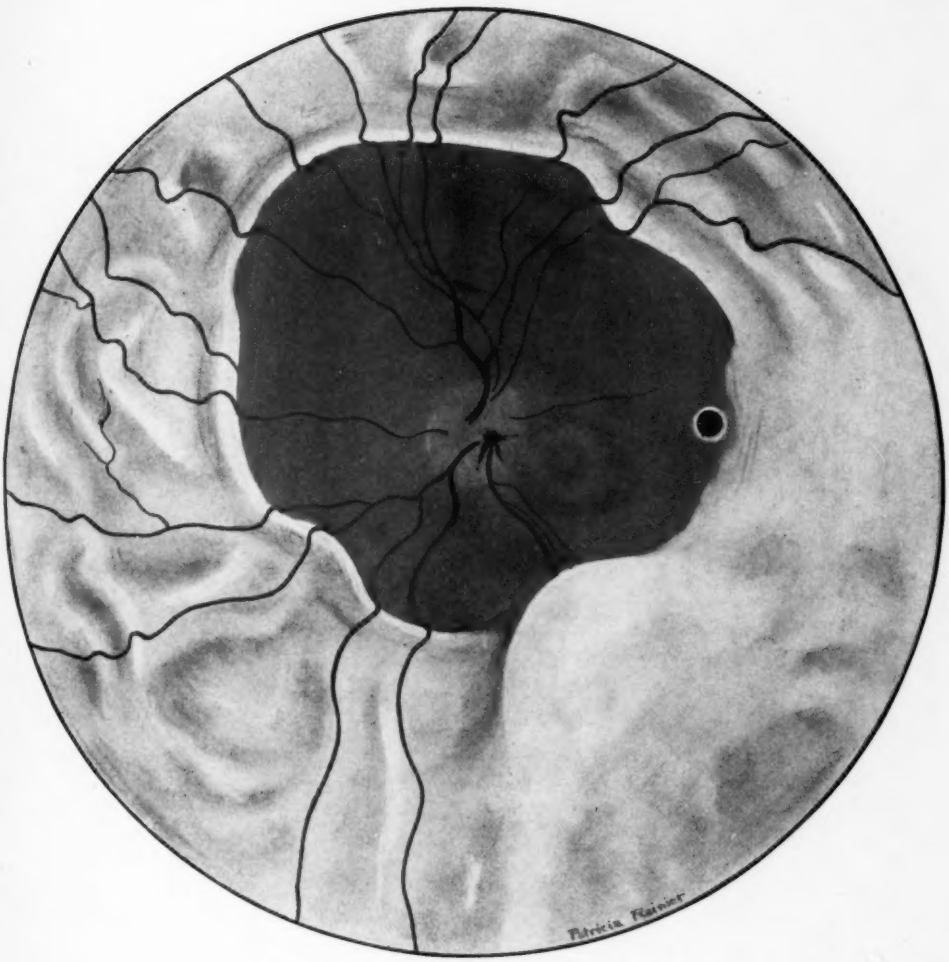
In the 3 cases of Weve the characteristic features were high myopia and extremely small holes in the macular area (in the first case a small triangular hole; in the second, punctate holes, and in the third, a very small round hole) with extensive detachment of the retina. In the first case the detachment was almost total except for a small sector in the upper nasal portion; in the second case there were a rather flat separation in the upper part and an extensive, bulging, cystlike detachment in the lower part, and in the third case, flat but extensive detachments were present in the lower and temporal upper portions.

REPORT OF A CASE

Recently, I observed a woman aged 46, the eyeground of whose left eye is reproduced in the figure. The patient had been examined for the first time ten years previously, when she had a refractive error of — 4.0 D. sph. ⌒ — 0.50 D. cyl.,

axis 180 in the right eye and —4.50 D. in the left eye. Vision in the right eye had become poor three months prior to the first examination, and the vitreous exhibited a large amount of dustlike opacities, which in transillumination appeared partly dark, and partly as bright, shiny spots. The vision was reduced to counting fingers at a distance of 0.5 meter, and was not improved with appropriate glasses. There was extensive detachment in the temporal lower part of the retina, the area of maximum separation being directed downward and measuring +8.0 D. The detachment showed the typical folding. In the direction of 6 o'clock 3 disk diameters distant from the optic disk, one heart-shaped and one pinhead-sized retinal hole were discernible. In the lower temporal region there was cystic degeneration of the retina, with splitting and numerous punctate holes. The detachment reached the ora serrata, which was widely torn off. The penetrating diathermic punctures resulted in closure of the holes and complete reattachment of the retina, and vision improved to 15/30. With proper correction, the left eye had normal vision, and there were no pathologic changes in the fundus. Almost ten years later the patient again presented herself. The condition of the right eye was unchanged; the field of vision showed slight peripheral indentation. Vision in the formerly normal left eye was limited to hand movements; the vitreous showed dustlike opacities, with a brownish emulsion visible with the slit lamp. The ophthalmoscopic appearance of the retina is well portrayed in the figure. In the macula there was a large, round, punched-out hole, one-third the size of the disk. The margins of the hole were apparently in contact with the underlying structures; the retina around the hole itself was not detached, but an almost circular detachment reached the periphery in every direction. The amount of detachment varied, but in some places amounted to +12.0 D. The detached retina showed the typical grayish discoloration. Ophthalmoscopic examination with red-free light testified to the complete hole formation. The most painstaking search failed to reveal the presence of peripheral holes or tears. Similarly, the history excluded the possibility of any traumatic origin of the macular hole.

The case presents many interesting features, first of which is the classic picture of the large, round, punched-out retinal hole with the simultaneous presence of an almost circular retinal detachment, approaching, but not reaching, the macular hole, without any peripheral lesion of the detached retina. The myopia amounted to only —4.50 D.; the patient was 46 years years of age; a previous examination had not revealed any pathologic change in the retina. The cystic degeneration of the retina characteristic of high myopia and the senile retina were not noted. The hole itself was not partial, but included the entire fovea, the picture often observed over long periods, without the lesion leading to retinal detachment. In addition, about ten years previously, at the age of 36, the right eye, with about the same refraction, exhibited retinal detachment with multiple peripheral holes and visible cystic degeneration of the retina; at the last examination the macular area of this eye was free of any pathologic change, even in red-free light. The development of the macular hole and the subsequent separation of the retina were rather rapid, as the intelligent and reliable patient had noted visual deterioration only ten days prior to the examination. The subjective complaints are the more trustworthy considering that the



Retinal detachment with hole in the macula.

patient had previously had a detached retina of the other eye and therefore had become a keen and anxious observer of herself. Any pathologic change would have had to manifest itself within a comparatively short period.

Perusal of the literature shows that the macular hole under discussion does not always represent the real macular hole as described in cases without associated detachment of the retina. In the classic form the macular hole is round, and punched-out margins and a floor of saturated red color are inevitable characteristics. The term "macular hole" is somewhat loosely applied. A pseudohole may exist in a honeycombed macula, and only examination in a red-free light will furnish the differentiation. A large cyst in which the anterior wall, the internal limiting membrane, is still intact is likely to simulate hole formation if not studied ophthalmoscopically with red-free light. Furthermore, the genuine macular hole represents a disk one-quarter or one-third the size of the average disk but may approach, or even exceed, the size of the disks. Another constant feature is that, the underlying choroid remaining intact, the ophthalmoscope offers a view of the choroid with the pigment epithelium intact, resulting in the saturated red color of the disk. In many instances, as previously mentioned, the size of the macular hole was that of a pinpoint and the floor of the hole was white; consequently, atrophic changes in the choroid must have been present, exposing the underlying sclera. In punctate holes the gap does not consist of the entire macula; possibly rupture of only one cystic space takes place. The hole is not necessarily located at the foveola itself but may be on its temporal or nasal slope. But the hole in some of the cases was not necessarily in the macula; the description often sounds as though the tear was paracentral (Rozenblyum [15]), or was a central hole between the macula and the disk. Finally, there were cases in which the macular hole was associated with peripheral tears. The latter should not be included with cases in which the macular hole is the only lesion present.

Peripheral holes may in rare cases occur without detachment. Recently, A. Knapp [16] reviewed the extensive literature and added 5 cases of his own to those reported. He stated that although this occurrence had been explained by the formation of chorioretinal adhesions, in 3 of his cases ophthalmoscopic study failed to reveal evidence of such changes. He excluded from his review the cases of macular hole without detachment. Macular holes are not to be included with retinal holes, since they are more benign than the peripheral holes

15. Rozenblyum, M. E.: Detachment of the Retina with Tear in the Macula, Vestnik oftal. **18**:644, 1941.

16. Knapp, A.: Peripheral Retinal Holes Without Detachment, Arch. Ophth. **30**:585 (Nov.) 1943.

or tears, frequently do not cause detachment or the detachment remains flat and circumscribed and are nonprogressive, with a tendency to spontaneous reattachment. In the absence of simultaneous peripheral lesion, extensive progressive detachment is infrequent, owing to the anatomic and physiologic peculiarities of the posterior pole. The smallness of the hole in the macula is not responsible for the nondevelopment of detachment, as relatively much smaller simple or multiple hole formation at the periphery is frequently the cause of extensive retinal detachment. The foveola is the thinnest area of the retina, according to Schwalbe. The thickening of the area surrounding the fovea reaches 0.49 mm., owing to an increase in the ganglion cell layer; the capillary net, absent in the foveola, appears at the margin. The large amount of nerve fibers are responsible for increased strength and elasticity, explaining the circumscribed nature of the hole and the absence of detachment. In the peripheral parts of the retina the nerve fibers and the vessels are preventive forces against tears; therefore the tears are usually along, but never perpendicular to, these elements. The direction of the nerve fibers and the vessels around the macular area act as a ring-shaped barrier, preventing the extension of retinal separation, which, accordingly, takes a horizontally oval form at its inception. The motility of the eye may represent a further influential factor, by promoting the detachment at the periphery, especially in the upper temporal part and inhibiting it in the central portion. To the aforementioned forces preventing detachment in cases of macular hole Meisner added the lack of traction on the outer coat through the tendons of the muscles; in cases of peripheral holes the insertions of the extraocular muscles, especially the external and the oblique muscles, are a potent factor.

31 Lincoln Park.

TENOTOMY OF THE SUPERIOR OBLIQUE MUSCLE FOR HYPERTROPIA

Preliminary Report

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HACKENSACK, N. J.

THE PURPOSE of this article is to describe a simple, effective and reliable surgical procedure for the cure of hypertropia associated with overaction of the superior oblique muscle.

Hypertropia is due to weakness of one or more of the vertically acting extraocular muscles. This weakness may be acquired or congenital. It may be due to a structural weakness of the muscle itself, to an anomalous insertion of the muscle tendon or to abnormal innervation. Of 107 cases of congenital paralyses of the vertically acting extraocular muscles, Duane [1] found the superior rectus muscle affected in 58 (54 per cent), the inferior rectus muscle in 36 (33 per cent), the superior oblique muscle in 7 (7 per cent) and the inferior oblique muscle in 6 (6 per cent). In a critical analysis of 1,955 cases of anomalies of the extraocular muscles, White and Brown [2] found the vertically acting muscles affected in 36.6 per cent of the cases, and in the same order of involvement as that observed by Duane. Of 70 cases of congenital paralyses of the extraocular muscles Posey [3] found the superior rectus muscle affected in 25. On the other hand, Bielschowsky [4] and Davis [5] found the superior oblique muscle most often affected.

CAUSE OF OVERACTION OF THE SUPERIOR OBLIQUE MUSCLE

Overaction of the superior oblique muscle occurs rarely as a primary spasm. It may be acquired or congenital. If acquired, it is generally

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1. Duane, A.: Congenital Deviations of the Eyes, Tr. Am. Ophth. Soc. **12**:981-1001, 1912.

2. White, J. W., and Brown, H. W.: Occurrence of Vertical Anomalies Associated with Convergent and Divergent Anomalies: Clinical Study, Arch. Ophth. **21**:999-1009 (June) 1939.

3. Posey, W. C., cited by Dunnington.[8e]

4. Bielschowsky, A.: Lectures on Motor Anomalies, Hanover, N. H., Dartmouth College Publications, 1940.

5. Davis, W. T.: Paresis of Right Superior Oblique and of Left Superior Rectus Muscle, Arch. Ophth. **32**:372-380 (Nov.) 1944.

due to surgical trauma to the homolateral inferior oblique muscle. If congenital, it is usually secondary to weakness of the homolateral inferior oblique muscle or to weakness of the contralateral inferior rectus muscle. Since these two muscles, the inferior oblique and the inferior rectus, are affected in about 39 per cent of congenital anomalies of the vertical-acting extraocular muscles, according to Duane's figures previously cited, spasm of the superior oblique muscle potentially occurs in this percentage of congenital vertical anomalies. Viewed in this light, spasm of the superior oblique muscle becomes an important factor in the vertical imbalances, vying in frequency with overaction of the inferior oblique muscle—a condition which occurs potentially in 61 per cent of the vertical imbalances.

SYMPTOMS AND OBJECTIVE FINDINGS ASSOCIATED WITH OVERACTION OF THE SUPERIOR OBLIQUE MUSCLE

Hughes and Bogart [6] stated that patients with overaction of the superior oblique muscle experience extreme discomfort, vertical diplopia and difficulty of fusion, especially in the lower fields of vision, and exhibit head tilting and torsion of the vertical axis of the affected eye. Patients with fusion may close one eye or turn the head or the entire body to avoid turning the eyes into the field of the overactive superior oblique muscle.

A hypertropia associated with overaction of the superior oblique muscle is usually associated with an exotropia or an exophoria. Occasionally one sees a patient with an overactive superior oblique muscle which is not associated with a horizontal tropia. These patients usually have fusion and depth perception in all directions of gaze except in the field of action of the overactive superior oblique muscle.

For the purpose of this article, all vertical deviations can be placed in one of three groups. In group 1, overaction of one or both inferior oblique muscles is present. This overaction usually is secondary to paresis of the contralateral superior rectus muscle or the homolateral superior oblique muscle. Vertical anomalies of this type are frequent and are improved by a tenotomy, a myectomy or a recession of the overactive inferior oblique muscle, irrespective of which muscle (the contralateral superior rectus or the homolateral superior oblique) was originally paretic.

In group 2, the hypertropia is associated with overaction of one or both superior oblique muscles. Cases of this type are less common than those of group 1, and the deviation can be improved or entirely cured by a tenotomy or a tenectomy of the overactive muscle.

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6. (*a*) Hughes, W. L., and Bogart, D. W.: Recession of Trochlea in Overaction of Superior Oblique, Am. J. Ophth. **25**:911-915 (Aug.) 1942. (*b*) Hughes, W. L.: Recession of the Trochlea for Reducing Action of Superior Oblique, ibid. **27**:1123-1131 (Oct.) 1944.

Hypertropia associated with an overactive superior oblique muscle can be differentiated from that produced by an overactive inferior oblique muscle by rotating the eyes temporarily. If the right superior oblique muscle is overactive, a left hypertropia will be present, which increases by having the patient look to the left. If the right inferior oblique muscle is overactive, a right hypertropia will be present, which increases when the patient looks to the left. In other words, if the right eye shoots upward in adduction, the right inferior oblique muscle is overactive. If it shoots downward, the right superior oblique muscle is overactive. These two conditions may be further differentiated by bringing the eyes to the up or to the down position in eyes directed to the left. A left hypertropia, due to an overactive right superior oblique muscle, increases as the eyes are carried from the horizontal plane in eyes directed to the left to a lower plane in eyes directed down and to the left. If the right inferior oblique muscle is overactive, the right hypertropia will increase as the eyes are carried from the horizontal plane in eyes directed to the left to a higher plane in eyes directed up and to the left. In cases of long-standing hypertropia the deviation may be almost the same when the eyes are directed up and to the left as when the eyes are directed down and to the left.

In group 3 may be placed all other types of hypertropia not associated with overaction of the oblique muscles. This group includes spasms of the vertically acting rectus muscles, combined insufficiencies and hypertropias not referable to paresis or spasm of any definite muscle.

TREATMENT OF HYPERTROPIA ASSOCIATED WITH OVERACTION OF THE SUPERIOR OBLIQUE MUSCLE

If the vertical deviation is 5 △ or less, prisms may give the patient comfort. Fusion exercises may increase the patient's ability to overcome his symptoms. If neither of these two forms of treatment gives relief, operation is indicated.

As a general rule, all surgical procedures on the vertically acting extraocular muscles are directed toward (1) strengthening the weak muscle; (2) weakening the direct antagonist, or (3) weakening the yoke muscle.

In cases of paralysis of the inferior rectus muscle associated with overaction of the contralateral superior oblique muscle, one may (1) strengthen the inferior rectus muscle by advancement, tucking or resection; (2) weaken the homolateral superior rectus muscle by tenotomy or recession, or (3) weaken the contralateral superior oblique muscle by recession of its pulley or by tenotomy or tenectomy of its reflected tendon.

In cases of paralysis of the inferior oblique muscle associated with overaction of the homolateral superior oblique muscle, one may (1)

strengthen the action of the inferior oblique muscle by tucking, resection or advancement; (2) weaken the action of the contralateral superior rectus muscle by tenotomy or recession, or (3) weaken the homolateral superior oblique muscle by recession of its pulley or by tenotomy or tenectomy of its reflected tendon.

In cases of paralysis of the inferior rectus muscle, White,[7] Dunnington,[8] Duane,[9] and Bielschowsky [4] advocated shortening the affected inferior rectus muscle. If this procedure is not adequate, White [7] advocated recession of the homolateral superior rectus muscle. In cases of paralysis of the inferior oblique muscle, Wheeler,[10] White [7] and Dunnington [8] advocated shortening the affected muscle by tucking, resection or advancement. If this is not adequate, White and Dunnington advocated recession or tenotomy of the contralateral superior rectus muscle.

Hughes and Bogart [6a] are the only authors who have advocated weakening an overactive superior oblique muscle in anomalies of the vertically-acting extraocular muscles. In 1942 [6a] they advocated recession of the pulley of the superior oblique muscle, stating that this is the only operation of the kind designed for this purpose. This operation requires a cutaneous incision, is technically not easy and has to be performed in a field traversed by the supratrochlear and infratrochlear nerves, the angular artery and vein and the terminal branches of the ophthalmic artery and vein. After the pulley and the adjacent periosteum have been freed from the underlying bone, the periosteum bearing the pulley must be pushed back into the orbit 10 to 15 mm. Because the periosteum is not sutured in place and one cannot be sure where the pulley will become attached, one has little control over the final result. In the average patient, if the pulley becomes permanently

7. White, J. W.: (*a*) The Choice of the Fixating Eye in Paralytic and Non-Paralytic Strabismus, Tr. Am. Ophth. Soc. **41**:319-324 1943; (*b*) Indications for Treatment for Combined Lateral and Vertical Strabismus, Arch. Ophth. **10**:585-592 (Nov.) 1933; (*c*) A Review of Twenty-Seven Years with the Obliques, Tr. Pacific Coast Oto-Ophth. Soc. **26**:112-131, 1941; (*d*) Surgery of the Inferior Oblique at or near Its Insertion, Tr. Am. Ophth. Soc. **40**:118-126, 1942; (*e*) Paralysis of the Superior Rectus and the Inferior Oblique Muscle of the Same Eye, Arch. Ophth. **27**:366-371 (Feb.) 1942; (*f*) Paralysis of Superior Rectus Muscle, Tr. Am. Ophth. Soc. **31**:551,584, 1933.

8. Dunnington, J. H.: (*a*) Diseases of the Extraocular Muscles, in Blumer, G.: Practitioner's Library of Medicine and Surgery, New York, D. Appleton-Century Company, Inc., 1937, pp. 303-328; (*b*) Hyperphoria: Its Etiology, Diagnosis and Treatment, Am. J. Ophth. **14**:1140 (Nov.) 1931; (*c*) Tenotomy of the Inferior Oblique, Tr. Am. Ophth. Soc. **27**:277, 1929; (*d*) Surgical Treatment of Strabismus, New York State J. Med. **38**:12-18 (Jan.) 1938; (*e*) Surgical Treatment of Strabismus, M. Rec. **35**:877-880 (June) 1941.

9. Duane, A., cited by Dunnington.[8b]

10. Wheeler, J. M.: Advancement of Superior Oblique and Inferior Oblique Ocular Muscles, Tr. Am. Ophth. Soc. **32**:232-244, 1935.

attached 10 mm. behind its previous point of attachment, it will be at or behind the equator of the globe. In this position, the superior oblique muscle can act only as an intorter of the vertical axis of the globe in the primary position.

Tenotomy or tenectomy of the superior oblique muscle has never been performed to relieve hypertropia in a patient with overaction of this muscle. Bonnet [11] tenotomized the oblique muscles to cure myopia. Von Graefe [12] advocated a "hands-off" policy with regard to operative procedures on the oblique muscles. Wilder [13] tenotomized the reflected tendon of the superior oblique muscle through a conjunctival incision on a cadaver but, so far as I know, never on a living patient. He mentioned a method for exposing and severing the tendon of the superior oblique muscle through a cutaneous incision, which he said would produce complete paralysis of the muscle. Spaeth [14] and Peter [15] cited the same procedure. Duane [16] simply stated that tenotomy of the superior oblique muscle may be done through a cutaneous incision through the brow. White [8c] stated that he had never seen a case in which tenotomy of the superior oblique muscle was indicated. Spaeth [14] expressed the belief that "tenotomy of the superior oblique should never be done except under the most extraordinary circumstances." Peter [15] stated that operation on the insertion of the superior oblique muscle is a questionable procedure. Dunnington [8] expressed the opinion of most authors when he stated that "it is not feasible to weaken the superior oblique muscle." It would seem, therefore, that today most ophthalmic surgeons are agreed that tenotomy of the superior oblique muscle is out of favor. It is interesting to note that tenotomy of the inferior oblique muscle was similarly regarded thirty or forty years ago.

In cases of paresis of the inferior rectus muscle or of the inferior oblique muscle associated with overaction of the superior oblique muscle, the idea that tenotomy of the superior oblique is difficult or dangerous has restricted ophthalmic surgeons to three surgical procedures in the relief of these conditions; namely, shortening the paretic inferior rectus muscle, weakening the homolateral superior rectus muscle and shortening the paretic inferior oblique muscle. None of these procedures is entirely satisfactory. In some cases of overaction

11. Bonnet, G., cited by Dunnington.[8c]

12. Von Graefe, A., cited by White.[7]

13. Wilder, W. H., in Wood, C. A.: A System of Ophthalmic Operations, Chicago, Cleveland Press, 1911, vol. 1, p. 703.

14. Spaeth, E. B.: Principles and Practice of Ophthalmic Surgery, Philadelphia, Lea & Febiger, 1944, p. 191.

15. Peter, L. C.: (*a*) Extraocular Muscles, Philadelphia, Lea & Febiger, 1941; (*b*) in discussion on White.[7d]

16. Duane, A., in Fuchs, E.: Text-Book of Ophthalmology, ed. 8, Philadelphia, J. B. Lippincott Company, 1924, p. 939.

of the superior oblique muscle, there is no demonstrable weakness of either the inferior rectus or the inferior oblique muscle, making it impossible to decide which of these two muscles should be strengthened. In cases of paresis of the inferior oblique muscle associated with overaction of the superior oblique muscle, resection, advancement or tucking of the paretic inferior oblique muscle is more effective if combined with tenotomy of the superior oblique. In cases of paresis of the inferior rectus, resection or shortening of this muscle lessens the vertical imbalance but cannot cure that part of the hypertropia due to overaction of the contralateral superior oblique muscle, especially when the paretic eye is used for fixation. Also, shortening the inferior rectus muscle has a tendency to narrow the palpebral fissure and to restrict the action of the superior rectus muscle. Recession of the homolateral superior rectus muscle in cases of paresis of the homolateral inferior rectus muscle or of the contralateral inferior oblique muscle tends to widen the fissure and to restrict the upward rotation of the globe. Tenotomy of the superior oblique muscle does neither of these things. It is not a difficult procedure. On the contrary, it is simpler and easier to perform than tenotomy, myectomy or recession of the inferior oblique muscle. It does not lead to torsional difficulties, to changes in the width of the fissure or to complete paralysis of the superior oblique muscle. The operation can be graded to meet the demands of each case with the same degree of accuracy and confidence as in tenotomy of the inferior oblique muscle. It is the procedure of choice in cases of paresis of the contralateral inferior rectus muscle or of paresis of the homolateral inferior oblique muscle when overaction of the superior oblique muscle is a factor in the hypertropia.

When one has a choice, it is fundamentally sounder surgical judgment to elect to weaken an overactive strong muscle, so that it will balance with an abnormally weak one, than to attempt to strengthen the weak muscle so that it will balance with the power of an overactive one. Fulton [17] stated that stretching a muscle increases its lifting power. The same thing cannot be said for resection or shortening of a weak muscle; otherwise the lifting power of a weak muscle would be progressively increased with each additional millimeter of resection until its ultimate power would be reached only when it was completely excised!

Tenotomy of the superior oblique muscle requires use of a general anesthesia in children. In adults only local anesthesia, induced with drop instillation of cocaine, is necessary. The operative field is practically bloodless and the operation painless unless unnecessarily strong traction is made on the tendon. The procedure is simple, easy and can be completed in five minutes. The operation leaves no visible

17. Fulton, J. F.: Muscular Contraction and Reflex Control of Movement, Baltimore, Williams & Wilkins Company, 1926.

scar, for the incision is made through the conjunctiva under the upper lid. The only difficulties associated with the operation are the uncertainty of identifying the reflected tendon and the question of deciding how much tendon to excise. The first difficulty is due to the large amount of Tenon's capsule and areolar tissue about the tendon. The second difficulty is one inherent in all operations on extraocular muscles.

ANATOMY OF THE SUPERIOR OBLIQUE MUSCLE

The superior oblique muscle originates at the apex of the orbit from the periosteum close to the annulus of Zinn. From its origin it runs

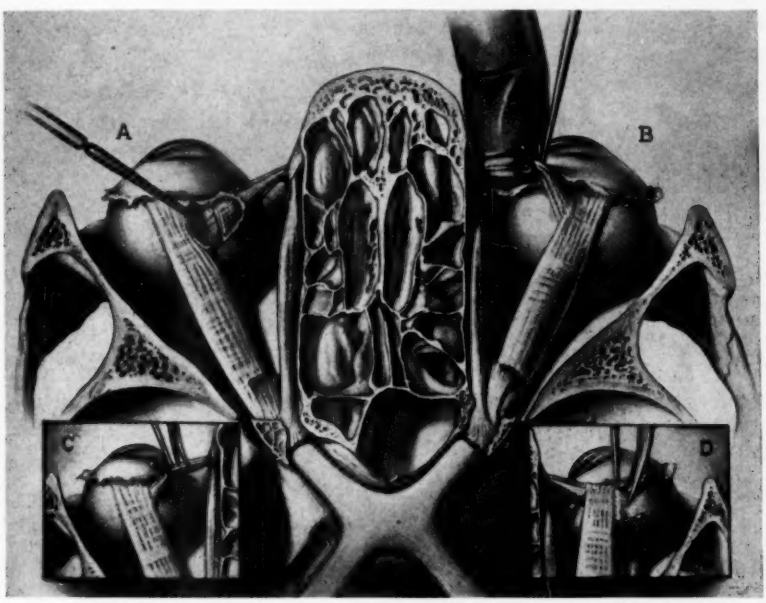


Fig. 1.—Horizontal section through the orbits (Tenon's capsule removed).

A, tenotomy of the left superior oblique muscle close to the nasal border of the superior rectus muscle. The sheath of the reflected tendon of the superior oblique has been opened and the superior rectus retracted to expose the tendon. Note the numerous fibrillar adhesions between the tendon and its sheath.

B, execution of the traction test. With traction on the muscle hook, and with the index finger over the pulley, the surgeon can feel the reflected tendon of the superior oblique muscle extending like a cord from the pulley toward the muscle hook. This will positively identify the tendon and its sheath.

C, site of section of the tendon of the superior oblique and its sheath for complete paralysis of the muscle.

D, position of muscle hook and scissors for tenotomy of the superior oblique at its insertion.

directly forward about 40 mm. along the superior nasal wall of the orbit to its pulley, just inside the orbital margin (fig. 1*A*). Here it turns backward at an angle of about 55 degrees to its previous course and

becomes inserted into the posterior part of the superior lateral quadrant of the globe. The tendon of the superior oblique muscle begins 8 to 10 mm. behind the pulley and, in passing through the latter, is compressed into a fibrous cord about 1 mm. wide and 2 mm. thick. After leaving the pulley, the tendon becomes wider and thinner as it approaches the globe. As it passes under the superior rectus muscle, it is only 2 or 3 mm. from the scleral attachment of this muscle. In operations, it is easy to pick up and incise the tendon of the superior oblique muscle at this point (fig. 1A). Under the superior rectus the tendon of the superior oblique muscle fans out and becomes so thin that it is transparent. Its insertion to the sclera is a curved line about 10 to 12 mm. long, with the concavity directed toward the pulley. The posterior end of this line is about 4 mm. from the optic nerve, while the anterior end is about 5 mm. from the lateral end of the attachment of the superior rectus muscle. The entire length of the tendon of the superior oblique muscle is 28 to 30 mm. and, with the eye in the primary position, is distributed as follows:

	Mm.
Length of tendon behind pulley	9
Length of tendon in pulley	4
Length of tendon from pulley to medial border of superior rectus	9
Length of tendon under superior rectus	8
Total length of tendon	30

The entire tendon of the superior oblique muscle is covered with a layer of areolar tissue, which extends from Tenon's capsule to the pulley and from the pulley backward along the superior oblique muscle for a distance of 8 to 10 mm. This tissue forms a sheath 2 to 3 mm. thick about the tendon, so that the tendon and its sheath together are about 5 to 6 mm. in diameter. Between the tendon and its sheath is a potential space, corresponding to that between the sclera and Tenon's capsule. Material, such as warm starch solution, injected under Tenon's capsule found its way from Tenon's capsule into this potential space.

The sheath of the tendon is remarkable for its many attachments, which extend to the sheath of the levator muscle, to the sheath of the superior rectus muscle, to the conjoined sheaths of the levator and the superior rectus muscle and to Tenon's capsule behind, below and laterally. This sheath completely encloses the pulley, from which extensions can be seen to pass to the septum orbitale, in front, to the muscle fibers of the superior oblique, behind, and to the periosteum, nasally. If the tendon of the superior oblique is dissected free of its sheath, it will be noted that the former is connected to the latter all along its course by many delicate areolar tissue fibrillae (figs. 1*A* and 2). These adhesions undoubtedly prevent the tendon from retracting too far within its sheath

after the tendon has been severed from the globe. It is the presence of these fibrillar attachments between the tendon and its sheath, on the one hand, and the many attachments of the sheath to the globe, on the other, which prevent the development of complete paralysis of the superior oblique muscle when its tendon is cut or partially removed.

In operations, the amount of weakening of the superior oblique muscle can be varied by the amount of tendon removed. If a slight effect is desired, it is necessary only to cut through the tendon close to the globe. If a larger effect is desired, some of the tendon must be removed. If complete paralysis is required, a portion of the entire sheath and its

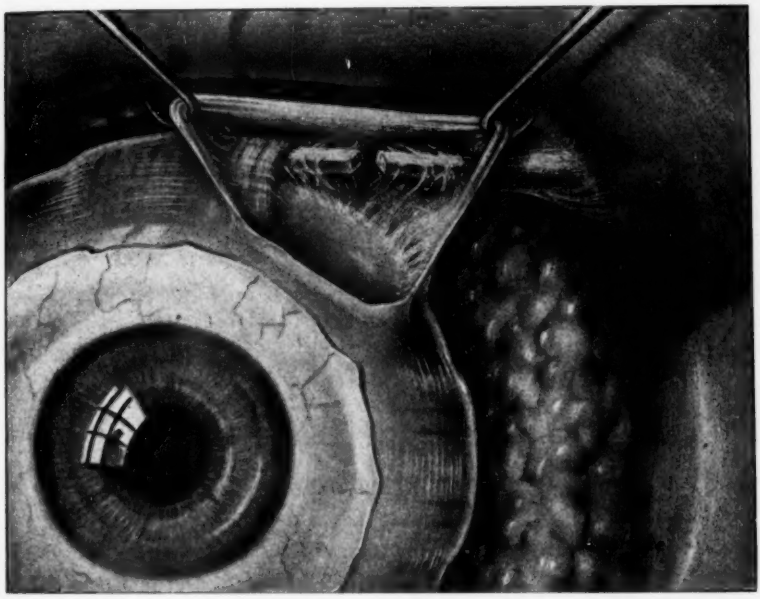


Fig. 2.—Illustration showing why complete paralysis does not develop after tenotomy of the superior oblique muscle. Note that the sheath of the reflected tendon of the superior oblique muscle is fused with Tenon's capsule, which has been opened on the nasal side of the superior rectus muscle to expose the two ends of the severed tendon of the superior oblique. Note the many adhesions between this tendon and its sheath. It is the presence of these numerous adhesions between the reflected tendon of the superior oblique muscle and its sheath, on the one hand, and the several attachments of the sheath to the globe, on the other, which prevents complete paralysis of the superior oblique muscle from developing after its tendon has been severed.

tendon, close to the pulley (fig. 1 *C*), should be excised. The truth of these statements was tested on a cadaver by the following experiment:

On one eye, a routine tenotomy of the superior oblique muscle was done through the conjunctiva on the nasal side of the superior rectus muscle. Then the roof of the orbit was removed, and the levator and superior rectus muscles were turned back over the globe to expose Tenon's capsule. Even though the tendon of the superior

oblique muscle had been thoroughly and completely incised by the previous operation, it was noted that backward traction on the superior oblique muscle caused the globe to be depressed and intorted. This traction was repeated several times, with the same result. Tenon's capsule was then removed and the sheath of the tendon of the superior oblique opened to make sure that no strands of the tendon remained between the globe and the pulley. This showed that only the sheath remained intact and that the cut tendon had retracted toward the pulley within its sheath. With further traction on the superior oblique muscle, the tendon was pulled through the pulley and 2 to 3 mm. behind it. Even then, with the cut end of the tendon in this abnormal position, traction backward on the superior oblique muscle still caused movement of the globe because of the attachments of its sheath to the globe, on the one hand, and the adhesions between the sheath and the superior oblique tendon, on the other.

The roof of the other orbit was then removed, and the tendon of the superior oblique muscle, after identification, was completely incised at its insertion under the superior rectus (fig. 1*D*). Traction on the superior oblique muscle again caused intorsion and downward movement of the globe, showing that the superior oblique continued to move the globe via its sheath even though the tendon had been completely severed from the sclera. Before ending the experiment, the tendon and its sheath were both completely cut close to the pulley (fig. 1*C*). After this, traction on the superior oblique muscle failed to have any effect on the globe.

This experiment demonstrated that tenotomy of the superior oblique muscle within its sheath only weakens its action but that cutting completely through the tendon and its sheath close to the pulley produces complete paralysis.

OPERATIVE PROCEDURE FOR TENOTOMY OF THE SUPERIOR OBLIQUE MUSCLE

The tendon of the superior oblique muscle may be cut through a cutaneous or through a conjunctival incision. If the conjunctival route is selected, the tendon may be severed under Tenon's capsule either on the lateral or on the medial side of the superior rectus muscle. The latter method is preferable, for three reasons: First, the tendinous insertion of the superior rectus need not be exposed; second, the tendon of the superior oblique is well forward at this point and is compressed into a band 6 to 7 mm. wide; third, there are no arteries, veins, nerves or other important structures here which might be injured. If the superior rectus has to be exposed, as in cases of resection of this muscle for paralysis of elevation, the tendon of the superior oblique can be cut at its insertion (fig. 1 *D*) or readily picked up and severed under the superior rectus muscle. Tenotomy of the superior oblique at its insertion is difficult and uncertain, because one cannot be sure that all the fibers of the tendon have been completely severed from the globe. Tenotomy of the superior oblique muscle is best performed on the nasal side of the superior rectus muscle by the technic to be described.

1. A self-retaining speculum or a Desmares lid retractor is inserted under the upper lid and the globe pulled down by means of a suture passed through the limbus at 12 o'clock. The conjunctiva and Tenon's capsule are incised for 10 to 12 mm. in the superior nasal fornix and the tissue between Tenon's capsule and the sclera undermined 10 to 12 mm. posteriorly.

2. A muscle hook is passed 10 to 12 mm. backward into the wound between Tenon's capsule and the sclera, with the hook flat against the latter (fig. 3), and the point is then turned upward toward the roof of the orbit, so as to engage the reflected tendon of the superior oblique muscle and its sheath.

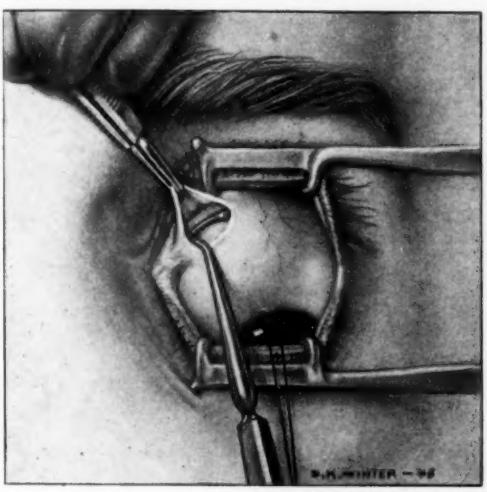


Fig. 3.—Insertion of the muscle hook for tenotomy of the left superior oblique. An incision has been made through the conjunctiva and Tenon's capsule and the latter undermined. Note the position of the point of the hook.

3. Before the contents are delivered on the hook into the wound, one should make sure, by means of the traction test (to be described), that the tendon and its sheath are on the hook (figs. 1 *B* and 4).

4. If the traction test gives a positive result, the reflected tendon and its sheath, together with a good deal of Tenon's capsule, will be on the hook. To identify the tendon, most of the tissue on the hook must be lifted off with forceps until a glistening, pearly white cord, the tendon of the superior oblique, is seen. If local anesthesia is used, the tendon can be positively identified by asking the patient to look up and down. If the tendon is on the hook, one will see it slide back and forth over the shank of the hook as the eye moves up and down.

5. After the tendon is identified, it is completely incised between the hook and the superior rectus. If a larger effect is desired, a hemostat is

placed on the tendon and an incision made close to the hemostat on either side, thus removing 3 to 5 mm. of tendon (fig. 5). Only the tendon should be excised, leaving the sheath behind. If more effect is desired, 6 to 8 mm. of tendon should be removed.

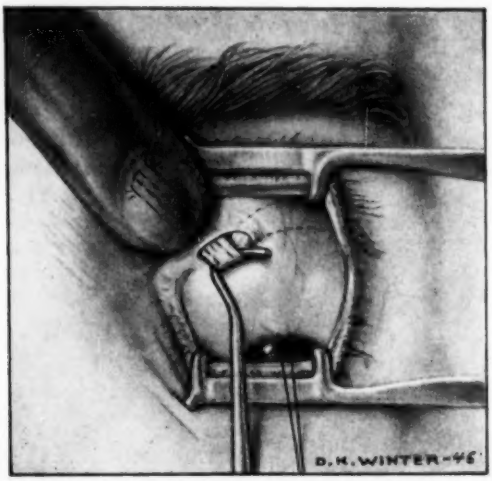


Fig. 4.—Execution of the traction test. The tendon of the superior oblique and its sheath have been engaged on the muscle hook and pulled into the wound. If the tendon has been picked up on the hook, the palpating finger, held over the pulley, should feel a cordlike band extending from the pulley to the shank of the muscle hook.

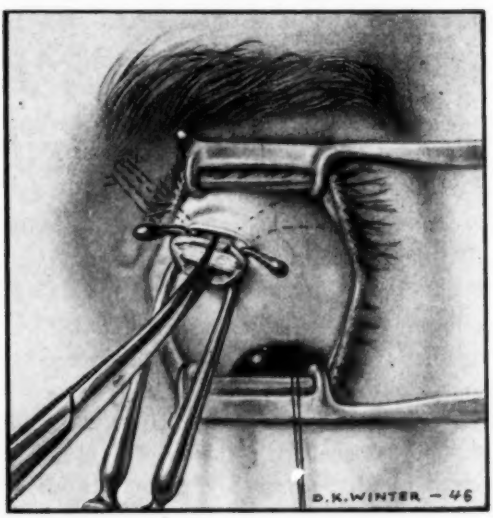


Fig. 5.—Cutting the tendon of the superior oblique muscle. The sheath of the tendon has been removed by blunt dissection and the latter exposed on two muscle hooks. For a simple tenotomy, the tendon is cut through with scissors; for a tenectomy, a mosquito forceps is applied to the tendon and the latter cut on either side of the clamp.

6. The conjunctiva is closed by means of one or two single interrupted plain surgical gut sutures and a monocular dressing applied for twelve to twenty-four hours.

TRACTION TEST

As previously stated, one difficulty associated with this operation is identification of the tendon of the superior oblique muscle. This difficulty is readily solved by use of the traction test, which is performed as follows: After the conjunctival wound has been made and Tenon's capsule undermined, a muscle hook is passed into the wound and brought forward. On the hook will be a mass of unfamiliar tissue, within the confines of which may be the tendon of the superior oblique muscle. Since one cannot be sure that the tendon is on the hook, one should determine definitely whether it is present in the tissue thus engaged before making any needless dissection. This is done by palpating the pulley through the skin with the index finger of one hand, while the other hand pulls forward on the hook (fig. 1 *B*). If the tendon or its sheath is on the hook, the index finger over the pulley will feel a cordlike structure extending from the pulley to the hook. Each time traction is made on the hook, the palpating finger over the pulley will feel a tug on the tendon. This test positively identifies the tendon and/or its sheath. If the tissues on the hook are now gently lifted off with forceps, one will find the pearly white, glistening tendon of the superior oblique muscle, which at this point is gathered into a cord about 2 mm. in diameter.

A word of caution should be given. The traction test is not infallible and may give a positive result if only a few fibers of the tendon or its sheath are engaged on the hook. If the hook is passed 10 to 12 mm. backward and brought forward, as previously directed, the tendon should always be engaged. If the tendon is not picked up on the hook on the first trial, the attempt should be repeated until the surgeon is certain that the tendon has been identified. Needless to say, if the tendon itself is not sectioned, but only a few fibers of its sheath are severed, the effect will be negligible. The only positive identification of the tendon is its pearly white, glistening luster. The sheath of the superior oblique muscle is white and semitendinous, but not glistening.

AMOUNT OF TISSUE TO BE REMOVED

It is impossible at this time to be dogmatic about how many prism diopters of hypertropia will be corrected by a tenotomy or by a tenectomy because of the intrinsic nature of all tenotomies of the extraocular muscles. However, it is safe to say that a tenotomy will produce less effect than a tenectomy, that a larger tenectomy will produce a greater effect than a smaller one and that the effect will be greater, the closer

the tenotomy or the tenectomy is done to the pulley. In other words, the effect may be varied depending on the amount of tendon removed and the place of its removal. If the tendon is cut close to the globe, the effect will be less; if cut close to the pulley, it will be greater. If both the tendon and its sheath are cut close to the pulley, complete paralysis may result. As a general rule, the following suggestions will not lead one far astray: (1) For a deviation of 5 to 10 △, a simple tenotomy is done; (2) for a deviation of 10 to 20 △, 3 to 5 mm. of the tendon is removed; (3) for 20 to 30 △ of deviation, 5 to 8 mm. of the tendon is excised,[18] and for (4) complete paralysis of the superior oblique, a part of the tendon and its sheath should be excised close to the pulley through a cutaneous incision.

INDICATIONS FOR TENOTOMY OF THE SUPERIOR OBLIQUE MUSCLE

Tenotomy of the superior oblique muscle should be performed whenever the muscle is overactive and the symptoms of the hypertropia cannot be relieved by nonoperative means. This operation may be combined with resection, advancement or tucking of the inferior oblique muscle, or with shortening operations on the contralateral inferior rectus muscle. In cases of paralysis of the third nerve and in cases of so-called paralysis of elevation, in which the inferior oblique and superior rectus muscles are weak, the superior oblique muscle should be tenectomized to increase the relative lifting power of the inferior oblique muscle. If the superior rectus muscle is being resected for relief of paralysis of elevation, it is a simple matter to excise a part of the tendon of the superior oblique under the superior rectus muscle at the same time.

REPORT OF CASES

CASE 1.—Mrs. M. A., aged 34, a billing clerk, stated that she had cut her right eye in childhood with a piece of glass. Later the right eye crossed; when she was 10 years old an operation was done to straighten the eye, but for the past fifteen years it had turned out. Examination of the right eye showed a scar of the cornea, which reduced her vision to 2/200, sinking of the caruncle and almost complete paralysis of the internal rectus muscle. An exotropia of 50 △ for 20 feet (6 meters) and for 13 inches (33 cm.) was present with the eyes in the primary position; the deviation measured 40 △ in eyes up and 55 to 60 △ in eyes down. In addition, there was a pronounced overaction of the right superior oblique muscle, which produced a left hypertropia of 10 △ with eyes in the primary position, increasing to 20 △ with eyes directed to the left and to 25 △ with eyes directed down and to the left. In June 1939 a recession of the external rectus and a resection of the internal rectus muscle on the right eye was done for correction of the exotropia. At the same time the overactive superior oblique muscle was tenotomized at its insertion under the superior rectus and the scar of the cornea tattooed. After

18. I have never removed more than 7 mm. at one time.

operation there was considerable edema of the lids and conjunctiva, which produced 3 to 4 mm. of ptosis of the upper lid. In two months the ptosis had cleared up. Six months after the operation, the patient had a cosmetically perfect result when the eyes were in the primary position, with slight limitation of abduction in the right eye. A suggestion of overaction of the superior oblique was noted when the right eye was rotated down and nasally. When she was last seen, seven years later, a moderate overaction of the right superior oblique muscle persisted.

Comment.—The tenotomy of the superior oblique muscle in this case was my first operation of the kind. It was gratifying to note that the overaction of the superior oblique muscle was reduced without producing complete paralysis, even after seven years. The postoperative edema and ptosis of the upper lid were at first thought to be due to the operation on the tendon of the superior oblique muscle. Instead, the ptosis may have been due to the operation on the internal and external rectus muscles, to the tattooing of the cornea or to a combination of all three operations. Ptosis did not develop in any of the other cases in which the superior oblique was tenotomized.

CASE 2.—P. I., a girl aged 6, had exotropia of three years' standing. Her general health was good. Birth was by cesarean section. There was no family history of exotropia or esotropia. Vision was 20/20 in each eye, and except for the muscular anomaly her eyes were entirely normal. Refraction with atropine cycloplegia revealed a small compound hyperopic astigmatic error. There was no limitation of abduction or adduction. For 20 feet there was variable exotropia, being 20 △ in eyes up, 30 △ in eyes straight ahead and 40 △ in eyes down. For 13 inches the exotropia was 30 △ in eyes up, 40 △ in eyes straight ahead and 50 △ in eyes down. For both 20 feet and 13 inches there was double hypertropia, with the left hypertropia predominating. In eyes right there was right hypertropia of 10 △, due to overaction of the left superior oblique muscle, and in eyes left, a left hypertropia of 15 △, due to overaction of the right superior oblique muscle (fig. 6*a*, *b* and *c*). The right hypertropia decreased in eyes up and right and increased in eyes down and right. The left hypertropia decreased in eyes up and left and increased in eyes down and left. Careful measurements of the deviation in the "corners" were not made because of poor cooperation. It was estimated that the right hypertropia in eyes down and right was 15 to 20 △ and the left hypertropia in eyes down and left was 20 to 25 △. A diagnosis was made of paresis of each inferior rectus muscle with overaction of each superior oblique muscle, the right superior oblique muscle being the more overactive. The patient was seen in consultation with Dr. J. H. Dunnington, who concurred in this diagnosis. In December 1941 a resection of the right internal rectus muscle and a recession of the right external rectus muscle were done, together with a tenotomy of both superior oblique muscles at their insertions. At the operation Tenon's capsule was disturbed as little as possible. After operation there was no ptosis and scarcely any reaction in the left eye except for a little redness under the upper lid. The conjunctiva of the right eye presented moderate reaction over the internal and external rectus muscles. One month after the operation there was esotropia for 20 feet and 13 inches of 5 to 11 △, with moderate overaction of the right superior oblique muscle in eyes left. On the synoptoscope there was an esotropia of

6 to 11 △, with a left hypertropia of 3 △. Because the patient had anomalous projection, fusion exercises were not given. Two months after operation there was orthophoria for 20 feet with the eyes in the primary position. At 13 inches there was moderate left hypertropia with eyes directed to the left, owing to persistent overaction of the right superior oblique muscle. Three years after the operation there was still overaction of each superior oblique muscle. The horizontal position of the eyes was excellent cosmetically, and the near point of convergence was fair. Four years after the operation there were for 20 feet a left hypertropia of 4 △ and an esophoria of 5 △ with the eyes in the primary position and the right eye

Fig. 6 (case 2).—Exotropia with overaction of each superior oblique muscle. Eyes before operation (*a-c*); eyes four years after operation (*d-f*).

(*a*) Both eyes looking to the right. Note that the right eye is looking up and to the right, while the left eye is directed down and to the right, owing to overaction of the left superior oblique muscle.

(*b*) Right eye looking straight ahead, and the left eye looking up and out.

(*c*) Both eyes looking to the left. Note that the right eye is directed downward, owing to overaction of the right superior oblique muscle.

(*d*) Both eyes looking to the right, with a residual overaction of the left superior oblique muscle after operation. Compare with *a*.

(*e*) Both eyes looking straight ahead. Note reduction of left hypertropia after operation as seen by comparing *b* and *e*.

(*f*) Both eyes looking to the left, with a residual overaction of the right superior oblique. Compare with *c*.

fixing. While the patient was fixating a light at 20 feet, rotation of the eyes to the right brought out a right hypertropia of 8 △, while rotation of the eyes to the left changed the right hypertropia to a left hypertropia of 10 △. The right eye was used for fixation in eyes directed to the left, and the left eye, in eyes directed to the right (fig. 6*d*, *e*, *f*). For 13 inches the measurements were as follows:

Eyes up and right	X′ 7 △*	RH′ 2 △
Eyes right	No X′	RH′ 8 △ (fig. 6 *d*)
Eyes down and right	XT^{v} 7 △	RHT^{v} 12 △
Eyes straight ahead	No X′ or S′	Double HT^{v} (fig. 6 *e*)
Eyes up and left	X′ 8 △	LH′ 2 △
Eyes left	X′ 7 △	LHT^{v} 12 △ (fig. 6 *f*)
Eyes down and left	XT^{v} 12 △	LHT^{v} 20 △

* In this tabulation, and in the accompanying tabulations, X and X′ indicate exophoria for distant and near vision; XT and XT^{v}, exotropia for distant and near vision; S and ST and S′ and ST^{v}, esophoria and esotropia for distant and near vision, respectively; RH and RHT and RH′ and RHT^{v}, right hyperphoria and right hypertropia for distant and near vision, respectively; and LH and LHT and LH′ and LHT^{v}, left hyperphoria and left hypertropia for distant and near vision, respectively.

The near point of convergence was 120 mm., and the patient did not have first degree fusion. Abduction and adduction were good.

Comment.—The persistent overaction of each superior oblique muscle after operation was most likely due to incomplete tenotomy. In tenotomy of the superior oblique muscle at its insertion, it is difficult to be certain that all the fibers have been severed from the globe because the insertion extends so far behind the equator. Later experience with this operation has taught me that a 5 mm. tenectomy on the nasal side of the superior rectus muscle would have produced a better result in this case. Another operation to remove a part of the tendon of each superior oblique at this time would most likely have reduced the hypertropia. This correction had been suggested, but permission for operation was refused by the parents. Operation has not been urged because the child has no symptoms referable to her vertical imbalance and because in the primary position her eyes are cosmetically straight. It has been contended by some surgeons that in cases of combined vertical and horizontal deviations the vertical deviation should be corrected first. Other surgeons have suggested that the horizontal deviation be corrected first. Both groups have insisted that if this is done the second component of the deviation may correct itself. In this case, correction of the horizontal deviation affected in no way the vertical deviation.

Case 3.—N. P., a boy aged 3½ years, had had exotropia of the left eye since 1 year of age, which had been getting worse for six months. For several months the parents had noticed that the child held his head turned to the right side when looking closely at objects. The general health was good. There was no family history of esotropia or exotropia. Examination showed that the right eye was the fixing eye with both eyes uncovered but that the left eye would fix if the right eye was covered. Refraction with atropine cycloplegia revealed a small, simple hyperopic refractive error. Abduction and adduction were good in each eye. The near point of convergence was remote and could not be measured. There was a variable

exotropia for 20 feet and 13 inches, being 20 △ when looking up, 30 △ when looking straight ahead and 50 △ when looking down. In the primary (horizontal) position the exotropia measured 30 △ for 20 feet and 13 inches. There was overaction of each superior oblique muscle, being greater in the left eye (fig. 7*a*, *b*, *c*). There was no detectable weakness of either inferior rectus or of either inferior

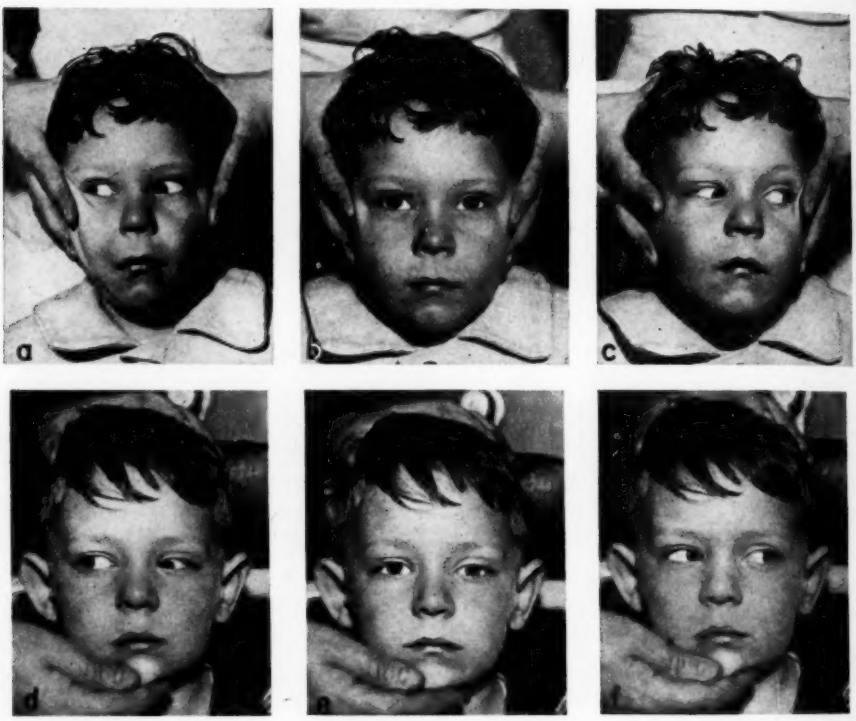


Fig. 7 (case 3).—Exotropia with overaction of each superior oblique muscle.

(*a*) Both eyes looking to the right. Note that the left eye is directed downward, owing to overaction of the left superior oblique muscle.

(*b*) Both eyes looking straight ahead and slightly up. Note that the right eye is higher than the left, owing to the greater overaction of the left superior oblique muscle.

(*c*) Both eyes looking to the left. Note that the right eye is directed downward, owing to overaction of the right superior oblique muscle.

(*d-f*) Eyes eighteen months after tenotomy of both superior oblique muscles on the nasal side of the superior rectus muscles, recession of the left external rectus muscle and resection of the left internal rectus muscle.

(*d*) Both eyes looking to the right after operation. Note the greater downward deviation of the left eye than shown in *a*, taken before operation. This is due to tenotomy of the right superior oblique without adequate tenotomy of the left superior oblique muscle.

(*e*) Both eyes looking straight ahead. Compare with *b*, and note the increased right hypertropia, owing to overaction of the left superior oblique muscle.

(*f*) Both eyes looking to the left. Compare with *c*, and note the decrease in overaction of the right superior oblique muscle.

oblique muscle. Miss Elizabeth K. Stark found an exotropia of 30 to 40 △ on the synoptophore and an exotropia of 40 △ for 20 feet and 55 △ for 13 inches with prisms. In May 1944 the left external rectus was recessed and the left internal rectus resected and both superior oblique muscles were tenotomized on the nasal side of the superior rectus muscles. The tendon of the right superior oblique muscle was easily identified and tenotomized, but that of the left was not well visualized and there was some doubt as to whether it was completely severed. One month after the operation the horizontal deviation was well corrected in the primary position, and there was no overaction of the right superior oblique muscle. However, there was a strong residual overaction of the left superior oblique muscle, especially with eyes directed to the right and with eyes directed down and to the right. One and one-half years after the operation there was a residual exotropia of 15 △, with a right hypertropia of 20 △ for 20 feet. When the eyes were rotated to the right, while looking at a light at 20 feet, the exotropia decreased to 10 △, but the right hypertropia increased to 25 △. At 20 feet there was an exotropia of 15 △ but no hypertropia when both eyes were directed to the left. For 13 inches there were a residual right hypertropia of 25 △ with eyes directed to the right (fig. 7 *d*), a right hypertropia of 15 △ with eyes in the primary position (fig. 7 *e*) and only 2 △ of right hypertropia with eyes directed to the left (fig. 7*f*).

For 13 inches the complete measurements were as follows:

Eyes up and right	XT′ 3 △	RHT′ 17 △
Eyes straight to the right	XT′ 7 △	RHT′ 25 △ (fig. 7 *d*)
Eyes down and right	XT′ 18 △	RHT′ 30 △
Eyes straight ahead	XT′ 18 △	RHT′ 15 △ (fig. 7 *e*)
Eyes up and left	No X′	RHT′ 2 △
Eyes straight to the left	XT′ 7 △	RHT′ 2 △ (fig. 7 *f*)
Eyes down and left	XT′ 25 △	RHT′ 4 △

Comment.—It should be noted in this case that the left hypertropia, due to overaction of the right superior oblique muscle, was practically cured by the operation (compare *c* and *f*, fig. 7). However, the right hypertropia, due to overaction of the left superior oblique muscle, was actually greater after the operation (compare *a* and *d*, fig. 7). The increased overaction of the left superior oblique was due to tenotomy of the right superior oblique muscle, the tendon of the left superior oblique having been missed at the time of operation. It is well known that tenotomy of one inferior oblique muscle in patients with overaction of both inferior oblique muscles will result in an apparently greater overaction in the nontenotomized inferior oblique muscle after operation. The same increase in the vertical imbalance develops postoperatively in cases with bilateral overaction of the superior oblique muscle when only one superior oblique is tenotomized.

This case demonstrates that the tendon of the superior oblique muscle should be positively identified before tenotomy is attempted; else no effect may be obtained. No harm can result from passing the muscle hook into the wound a second time to make sure the tendon has been completely severed. In cases in which the superior oblique of one eye is

more overactive than that of the other, the operation must be graded so that one superior oblique muscle is weakened more than the other.

Case 4.—E. L., a youth aged 18, stated that his eyes had been turned out since he was a baby. His birth was by forceps delivery. He had worn glasses since 4 years of age. His general health was good. Vision was 20/15 in the right eye with a –2.75 D. sphere and 20/15 in the left eye with a –2.25 D. sphere. Except for the myopia and the anomaly of the extraocular muscles, his eyes were normal. Abduction and adduction were good. The convergence near point was remote and could not be measured. No weakness was noted in either the inferior rectus or the inferior oblique muscles. For 20 feet and 13 inches he had a variable exotropia of 50 to 65 △, depending on the direction of gaze, complicated by overaction of each superior oblique muscle (fig. 8*a*, *b* and *c*). With the right eye fixing the left eye moved up under cover, and with the left eye fixing the right eye moved up under

Fig. 8 (case 4).—Exotropia with overaction of each superior oblique muscle.

(*a*) Both eyes looking to the right and downward. Note the pronounced downward deviation of the left eye, owing to overaction of the left superior oblique muscle.

(*b*) Both eyes looking straight ahead, with the right eye fixing. Note the upward deviation of the left eye. With the left eye fixing, the right eye deviated upward.

(*c*) Both eyes looking to the left and downward. Note the pronounced downward deviation in the right eye, owing to overaction of the right superior oblique muscle.

(*d-f*) Eyes six months after operation.

(*d*) Both eyes looking to the right. Compare with *a*, and note the great improvement in the vertical deviation, owing to tenotomy of the left superior oblique.

(*e*) Both eyes looking straight ahead. Compare with *b*.

(*f*) Both eyes looking to the left. Compare with *c*, and note the decrease in the vertical deviation, owing to tenotomy of the right superior oblique muscle.

cover. Measurements of the imbalance of the extraocular muscles in the different directions of gaze were as follows:

Eyes up and right	XT^{v} 50 △	No HT^{v}
Eyes straight to the right	XT^{v} 55 △	RHT^{v} 10 △
Eyes down and right	XT^{v} 50 △	RHT^{v} 25 △ (fig. 8 *a*)
Eyes straight up	XT^{v} 60 △	No HT^{v}
Eyes straight ahead	XT^{v} 65 △	Double HT^{v} (fig. 8 *b*)
Eyes straight down	XT^{v} 65 △	RHT^{v} 8 △
Eyes up and left	XT^{v} 50 △	No HT^{v}
Eyes straight to the left	XT^{v} 50 △	LHT^{v} 5 △
Eyes down and left	XT^{v} 60 △	LHT^{v} 25 △ (fig. 8 *c*)

In September 1943, both internal rectus muscles were resected, both external rectus muscles recessed and both superior oblique muscles tenotomized. The right superior oblique was tenotomized lateral to the superior rectus muscle, and the left superior oblique, medial to the superior rectus muscle. The patient made an excellent postoperative recovery. Six months after the operation the eyes were cosmetically straight for both 20 feet and 13 inches (fig. 8*e*). With the eyes in the primary position for near vision there was a slight residual double hypertropia in the cover test. In rotation of his eyes to the right (fig. 8*d*) there was still present a slight right hypertropia, of about 5 △, due to a residual overaction of the left superior oblique muscle. In rotation of his eyes to the left, there was still present a slight left hypertropia of about 5 △ (fig. 8*f*), due to residual overaction of the right superior oblique muscle.

Comment.—This patient obtained an excellent postoperative result. The exotropia, as well as the right hypertropia, was well corrected in eyes right (compare *a* and *d* in figure 8) and the left hypertropia in eyes left (compare *c* and *f* in figure 8). In this case, there was no detectable difference in the effect of the two tenotomies, the right superior oblique muscle having been tenotomized at its insertion lateral to, and the left superior oblique muscle medial to, the superior rectus, both under Tenon's capsule. In general, it can be said that tenotomy of the superior oblique lateral to the superior rectus (i.e., at its insertion to the globe) is less certain in its effect than tenotomy on the nasal side of the superior rectus.

The prism measurements before and after operation were carefully taken in the six cardinal directions of gaze. Even though the patient was most cooperative, it was difficult to measure the horizontal and vertical deviations to within less than 5 △ of the true error present because of the tendency of these measurements to vary with the direction of the eyes, the position of the prisms, the patient's attention and other mechanical and physiologic factors. In all cases the measurements were carefully and conscientiously taken, but some allowance must be made for human error on the part of the patient and the physician.

CASE 5.—Mrs. H. R., aged 25, complained of eyestrain, headaches above the eyes and confusion of print when reading. At times she saw double when looking to the right or to the left. She had tried several pairs of glasses and fusion

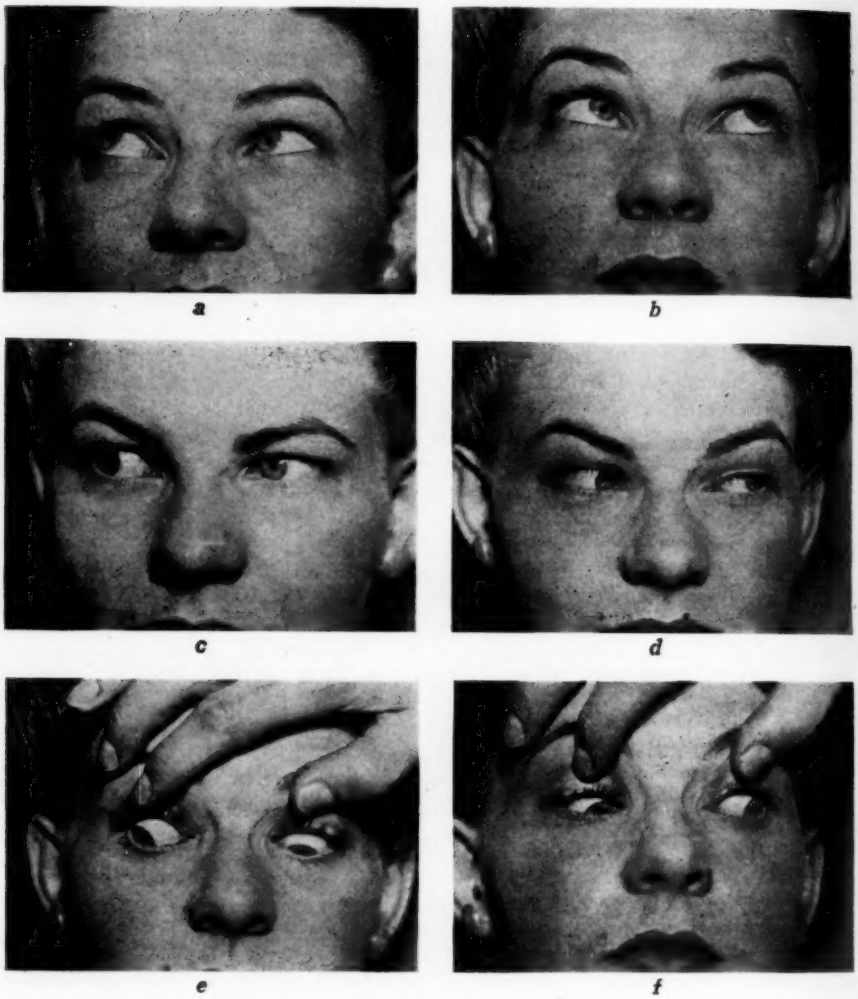


Fig. 9 (case 5).—Overaction of each superior oblique muscle before operation (*a-h*) and after (*d-e*) the last tenectomy.

(*a*) Both eyes looking up and to the right. Note the right hypertropia.

(*b*) Both eyes looking up and to the left. Note the left hypertropia.

(*c*) Both eyes looking to the right. Note the right hypertropia, owing to overaction of the left superior oblique muscle.

(*d*) Both eyes looking to the left. Note the left hypertropia, owing to overaction of the right superior oblique muscle.

(*e*) Both eyes looking to the right and down. Note the right hypertropia, owing to overaction of the left superior oblique muscle.

(*f*) Both eyes looking to the left and down. Note the left hypertropia, owing to overaction of the right superior oblique muscle.

g

h

i

j

k

l

(*g*) Both eyes directed up and to the right. Compare with *a*.

(*h*) Both eyes directed up and to the left. Compare with *b*.

(*i*) Both eyes directed to the right. Compare with *c*, and note the higher position of the left eye in *i*.

(*j*) Both eyes directed to the left. Compare with *d*, and note the higher position of the right eye in *j*.

(*k*) Both eyes directed to the right and downward. Compare with *e*, and note the higher and improved position of the left eye in *k*.

(*l*) Both eyes directed downward and to the left. Compare with *f*, and note the higher and improved position of the right eye in *l*.

exercises, without relief. Examination showed defective depth perception, a moderate amount of astigmatism and double hypertropia, due to overaction of each superior oblique muscle. Refraction with homatropine-paredrine cycloplegia showed the following error:

Right eye: + 0.50 D. sph. ⊃ + 1.50 D. cyl., axis 110, vision 20/20
Left eye: + 1.50 D. cyl., axis 80, vision 20/20.

With the prescription in place, the near point of accommodation was 12 cm. for each eye. For 20 feet the patient had 1 △ of left hyperphoria and 3 △ of esophoria. Her near point of convergence was normal.

This patient had two operations on the tendon of each superior oblique muscle before she was comfortable. Before the first operation, there was right hypertropia of 12 △ in eyes directed to the right, left hypertropia of 20 △ in eyes directed to the left and double hypertropia in the primary position for distance. For 13 inches in the different directions of gaze, the measurements were:

Eyes up and right	XT′ 5 △	RHT′ 10 △ (fig. 9 *a*)
Eyes right	No X′	RHT′ 12 △ (fig. 9 *c*)
Eyes down and right	XT′ 15 △	RHT′ 15 △ (fig. 9 *e*)
Eyes up and left	ST′ 5 △	LHT′ 10 △ (fig. 9 *b*)
Eyes left	ST′ 7 △	LHT′ 20 △ (fig. 9 *d*)
Eyes down and left	XT′ 10 △	LHT′ 20 △ (fig. 9 *f*)

The first operation was done in August 1944 on the tendons of both superior oblique muscles with local anesthesia through a conjunctival incision. The tendon of each superior oblique muscle was identified on the nasal side of the superior rectus and severed with as little trauma as possible. In view of the undercorrection which resulted, it would have been wiser to remove a part of each tendon instead of merely incising it.

Six weeks after operation, the patient presented 1 △ of right hyperphoria for 20 feet and 4 △ of esophoria with the Maddox rod. For near vision measurements for the extraocular muscle were:

Eyes up and right	RHT′ 5 △ (a reduction in RHT′ of 5 △)
Eyes right	RHT′ 16 △ (an increase in RHT′ of 4 △) (fig. 10 *a*)
Eyes down and right	RHT′ 20 △ (an increase in RHT′ of 5 △)
Eyes up and left	LHT′ 10 △ (no change in HT′)
Eyes left	LHT′ 10 △ (a reduction in LHT′ of 10 △) (fig. 10 *c*)
Eyes down and left	LHT′ 7 △ (a reduction in LHT′ of 13 △)

These measurements and the pictures taken after operation (fig. 10 *a* and *c*) show that each superior oblique muscle was still overactive, the overaction of the left superior oblique in eyes directed to the right being definitely greater than the overaction of the right superior oblique in eyes directed to the left. Therefore, the left superior oblique muscle was tenectomized, with use of local anesthesia, six weeks after the first operation. An incision was made through the conjunctiva in the superior nasal quadrant. Scar tissue from the previous operation was encountered, but the sheath of the reflected tendon was easily picked up and identified. A hemostat was applied to the tendon, and the sheath and the tissue in the clamp were excised by cutting on either side of it. After this, the patient, whose eyes were uncovered, was asked to look to the right. Some overaction of the left superior oblique muscle persisted. Therefore, the hook was passed deeper into the wound and another bite of the sheath of the tendon of the superior oblique

muscle removed. After this maneuver, the overaction of the left superior oblique was reduced to what appeared to be less than 5 △.

Four days after the operation the overaction of the left superior oblique muscle had been changed to slight paresis in extreme rotation of the eyes down and to the right. This paresis later disappeared entirely. At that time the right hyper-

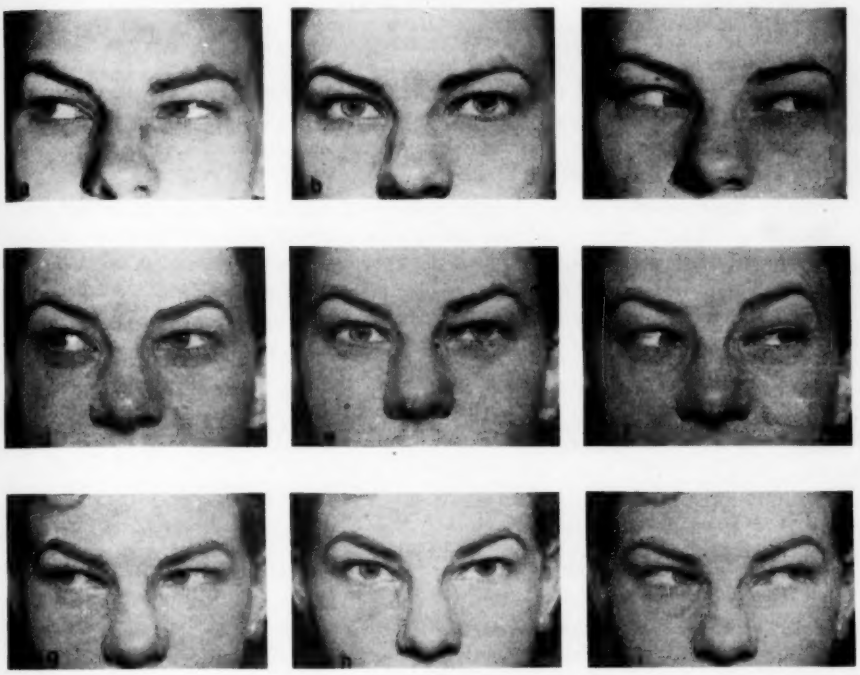


Fig. 10 (case 5).—(*a-b*) Eyes six weeks after the first operation on the left superior oblique tendon.

(*a*) Both eyes directed to the right. Compare with figure *9c*, and note that the patient still has a pronounced right hypertropia, owing to residual overaction of the left superior oblique muscle.

(*b*) Both eyes looking straight ahead.

(*c*) Both eyes looking to the left, six weeks after the first operation on the right superior oblique tendon. As compared with figure *9c*, there appears to be less overaction of the right superior oblique muscle after operation.

(*d-f*) One month after the second operation on the left superior oblique tendon.

(*d*) Both eyes directed to the right. Note that the right hypertropia shown in *a* has been greatly reduced.

(*e*) Both eyes looking straight ahead.

(*f*) Both eyes looking to the left. Compare with *c*, and note that the left hypertropia shown in *f* is greater than before the second operation.

(*g-i*) One month after the second operation on the right superior oblique tendon.

(*g*) Both eyes looking to the right.

(*h*) Both eyes looking straight ahead.

(*i*) Both eyes looking to the left. Compare with *f* and note the great improvement in the overaction of the right superior oblique muscle.

tropia in the up and down positions of eyes directed to the right was well corrected, but the left hypertropia in eyes directed to the left seemed greater than before the second operation. One month later the measurements were:

Eyes up and right	RH′	5 △ (no change in RHT′)
Eyes right	RH′	5 △ (a reduction in RHT′ of 11 △) (fig. 10 *d*)
Eyes down and right	LH′	5 △ (a reduction in RHT′ of 15 △)
Eyes up and left	LHT′	15 △ (an increase of LHT′ of 5 △)
Eyes left	LHT′	18 △ (an increase of LHT′ of 8 △) (fig. 10 *f-e*)
Eyes down and left	LHT′	20 △ (an increase of LHT′ of 13 △)

Diplopia fields showed that the patient was able to fuse in all positions of the binocular fields except in eyes up and left, eyes left, eyes down and left and in eyes straight down. The greatest separation of images was in eyes down and left, i. e., in the field of action of the right superior oblique muscle.

The right superior oblique muscle was tenectomized ten weeks after the first operation. Again, there were scar tissue and slight difficulty in picking up the tendon of the superior oblique muscle. A hemostat was applied to the tendon and its sheath and a part of both excised by cutting on either side of the hemostat. After this, the overaction of the right superior oblique muscle was relieved.

One month after the last operation measurements of muscle balance showed:

Eyes up and right	X′ 3 △	RH′ 3 △
Eyes right	No X′	RH′ 3 △ (fig. 10 *g*)
Eyes down and right	No X′	No H′
Eyes straight	Orthophoria (fig. 10 *h*)	
Eyes up and left	S′ 5 △	LH′ trace
Eyes left	S′ 5 △	LH′ trace (fig. 10 *i*)
Eyes down and left	S′ 5 △	LH′ trace

The astigmatic axis had changed from 110 to 120 degrees in the right eye and from 80 to 72 degrees in the left eye. With her glasses she had 20/15—2 vision in each eye, an esophoria of 5 △ and a left hyperphoria of 1 △ for 20 feet with the Maddox rod. Her diplopia fields were normal in all directions of gaze except in extreme rotation up and to the left, where there was a slight separation of the two images with a red glass over one eye and a green glass over the other. Without colored glasses, she had no diplopia in any of the fields. When last seen, six and one-half months after the last operation, she stated that she had had no more headaches or diplopia and that she could read as much as she liked without symptoms of eyestrain. She volunteered the information that her "eyes felt wonderful since the operation." Her final check-up showed:

Eyes up and right	RH′ 2 △	(fig. 9 *g*)
Eyes right	RH′ 2 △	(fig. 9 *i*)
Eyes down and right	RH′ 3 △	S′ 4 △ (fig. 9 *k*)
Eyes up and left	No H′	X′ 2 △ (fig. 9 *h*)
Eyes left	RH′ 4 △	S 3 △ (fig. 9 *j*)
Eyes down and left	No H	(fig. 9 *l*)

In the primary position for 20 feet with the Maddox rod, she had left hyperphoria of 1 △ and esophoria of 4 to 6 △, and for 13 inches, orthophoria. With the Maddox rod there seemed to be 5 degrees of outward cyclophoria in the right eye but no cyclophoria in the left eye. Her near point of convergence was 60 mm. With the Keystone fusion card no. DB33781, she had 20/20 fusion. Insignificant conjunctival scars were noted under the upper lids.

Comment.—The excellent cosmetic and functional result in this case can be seen by comparing pictures taken in the six cardinal directions of gaze before and after operation (fig. 9). One should compare especially the right hypertropia and exotropia present before operation, when the eyes were directed down and to the right (fig. 9*e*), with the final postoperative result in the same position (fig. 9*k*). Also, the pronounced left hypertropia present when the eyes were rotated down and to the left before operation (fig. 9*f*) should be compared with the final postoperative result in this position (fig. 9*l*).

Two items in this case require further comment, namely, the need of more than one operation and the apparent increase in overaction of one superior oblique muscle after operation on the opposite superior oblique muscle. The need of two operations on each superior oblique muscle must be attributed to lack of experience and to timidity. Because this patient had binocular single vision with some fusion, the surgeon was anxious not to produce a troublesome postoperative diplopia. The experience gained in this and in subsequent cases would tend to indicate that when the vertical deviation is more than 10 Δ a part of the tendon of the superior oblique muscle must be removed to produce adequate correction.

After the first operation on the tendon of each superior oblique, an apparent increase in overaction of the left superior oblique muscle developed. When the left superior oblique muscle was tenotomized a second time, an apparent increase in the overaction of the right superior oblique muscle developed. This is best explained by recalling that in cases of bilateral overaction of the inferior oblique muscle tenotomy of one inferior oblique muscle causes an apparent increase in the overaction of the opposite inferior oblique muscle. The same phenomenon would develop if one superior oblique muscle was tenotomized more completely than the other. Therefore, to get a satisfactory result in a case of bilateral overaction of the superior oblique muscle, the operation must be graded to fit the amount of overaction present. If the vertical deviation is equal, an equal tenotomy or tenectomy on the two muscles is indicated. If unequal, more tendon must be removed from the more overactive superior oblique muscle.

As previously stated, some surgeons recommend correction of the vertical deviation before attempting correction of the horizontal deviation in cases of combined vertical and horizontal squint, contending that this procedure obviates the need of a second operation to correct the horizontal deviation. This procedure worked out well in this case, as can be seen by comparing the combined horizontal and vertical deviation

present before operation (fig. 9 *e* and *f*) with that present after the superior oblique muscles had been tenectomized (fig. 9 *k* and *l*).

CASE 6.—L. R., a Negro aged 21, came to the Vanderbilt Clinic to have his right eye straightened. He stated that vision in the right eye had been poor all his life, owing to the presence of a "white spot" over the pupil since he was a baby, and that the right eye had been crossed for years. Examination showed vision equal to counting fingers at 3 feet (90 cm.) in the right eye and 20/20 in the left eye. The poor vision in the right eye was due to a dense, white corneal leukoma with incarceration of the iris. Because of the amblyopia present in the right eye, the esotropia present could not be carefully measured with the cover test. With prisms held before the fixing eye, the esotropia was estimated to be 30 △ for distant and near vision. A strong overaction of the right superior oblique was present, which produced a left hypertropia of about 20 △ in eyes left (fig. 11). The patient was sent to the hospital, where the corneal leukoma was tattooed, the right superior oblique muscle tenotomized through the conjunctiva on the nasal side of the superior rectus muscle and the right internal rectus muscle recessed. On his leaving the hospital, ten days later, the right

Fig. 11 (case 6).—(*A*) Both eyes looking straight ahead, with the left eye fixing. Note the corneal scar, the slight esotropia and the right hypertropia in the right eye. (*B*) Both eyes looking to the left, with the left eye fixing. Note the marked downshoot of the right eye, owing to spasm of the right superior oblique muscle.

eye was cosmetically straight, with slight residual overaction of the right superior oblique muscle. The patient did not return to the clinic for follow-up care.

Comment.—In view of the undercorrection obtained in this case with simple tenotomy, it would have been better to excise 5 mm. of the tendon. This was not done because of the fear of producing an overeffect.

CASE 7.—N. C., a girl aged 9, came to the Vanderbilt Clinic in 1943 complaining of a crossed left eye of several years' duration. Examination showed vision of 20/30 in the right eye and 20/50 in the left, improved with glasses to 20/20—2 in the right eye and to 20/30 in the left. An exotropia of 55 △ for distant and near vision was noted, complicated by a right hypertropia of 7 △ for near vision. There was no increase of the hypertropia in the six cardinal directions of gaze. Otherwise, the eyes were essentially normal.

In July 1943 a 4 mm. recession of the internal rectus and a 10 mm. resection of the external rectus muscle were done. The patient made an uncomplicated

postoperative recovery. When she was seen in January 1946, the cosmetic result was excellent in the primary position, but the cover test revealed right hypertropia in all positions of gaze, as recorded below:

Eyes up and right	XT′ 16 △	RHT′ 27 △
Eyes right	XT′ 10 △	RHT′ 22 △
Eyes down and right	XT′ 10 △	RHT′ 18 △
Eyes straight	ST′ 5 △	RHT′ 12 △
Eyes up and left	XT′ 16 △	RHT′ 18 △
Eyes left	XT′ 0	RHT′ 10 △
Eyes down and left	XT′ 0	RHT′ 10 △

The right hypertropia in eyes directed up and to the right was due to acquired weakness of the left inferior oblique muscle. Since this weakness was not present before the operation two and one-half years before, it seemed that the inferior oblique must have been injured during the operation on the external rectus, when the latter was being freed from Tenon's capsule. Because of the close association of these two muscles on the lateral surface of the globe, the inferior oblique is easily injured unwittingly. The right hypertropia in the right lower corner was due to overaction of the left superior oblique, secondary to weakness of the left inferior oblique. The right hypertropia in the left upper corner was thought to be due to overaction of the right inferior oblique.

To correct the vertical deviation, three operations were considered, namely, (1) tenectomy of the left superior oblique, (2) advancement of the left inferior oblique and (3) myectomy of the right inferior oblique muscle. It seemed that the safest procedure was to do these operations at different times. Therefore, on Jan. 17, 1946, a 5 mm. tenectomy of the left superior oblique was done, with the patient under general anesthesia.

One week after the operation the deviation measured:

Eyes up and right	XT′ 12 △	RHT′ 24 △
Eyes right	XT′ 10 △	RHT′ 12 △
Eyes down and right	XT′ 0-5 △	RHT′ 0.5 △
Eyes straight	.....	RHT′ 0-5 △
Eyes up and left	XT′ trace	RHT′ 14 △
Eyes left	XT′ trace	RHT′ 5 △
Eyes down and left	XT′ trace	RHT′ 8 △

Comment.—The operation on the left superior oblique muscle reduced the right hypertropia in eyes directed down and to the right from 18 to 5 △ (sometimes 0). Therefore, the tenectomy of the left superior oblique did everything that could have been hoped for in reducing the right hypertropia in eyes directed down and to the right. A shortening of the left inferior oblique is contemplated at some later date. When the patient was last seen, six months after the operation, the vertical deviation was essentially the same as the measurements taken one week after operation.

CASE 8.—C. L., a girl aged 3 years, had a crossed right eye of one year's duration. There was no history of esotropia in the parents or grandparents; birth was by normal delivery, and the general health was good.

Examination showed normal eyes except for an esotropia of 40 △ for distance and 50 △ for near vision, associated with a left hypertropia of 20 △, due to a pronounced overaction of the left inferior oblique muscle. Examination with atropine cycloplegia showed a small amount of compound hyperopic astigmatism of each eye. The child was too young to cooperate in recording the visual acuity, but it was noted that the left eye was the fixing eye. In August 1943 the child was sent to the hospital to have a recession of the right internal rectus muscle, a resection of the right external rectus muscle and a myectomy of the overactive left inferior oblique. By mistake, the recession and resection were done on the left eye, and the normal right inferior oblique was myectomized.

After the operation, the esotropia was fairly well corrected, but the left hypertropia, due to overaction of the nonmyectomized left inferior oblique, was unchanged. In addition to an upshoot of the left eye when both eyes were directed to the right (overaction of the left inferior oblique muscle), there was now a right hypotropia (left hypertropia) in eyes directed up and to the left, owing to weakness of the myectomized right inferior oblique. Associated with the weakness of the right inferior oblique was an overaction of the right superior oblique, which increased the left hypertropia in eyes directed down and to the left. The condition did not change in the following two years. In October 1945 the following operation was done: (1) myectomy of the left inferior oblique muscle, (2) tenectomy of the right superior oblique muscle and (3) resection of the right external rectus muscle. The measurements of squint before the last operation were:

Eyes up and right	ST' 15 △	LHT' 25 △
Eyes right	ST' 25 △	LHT' 20 △
Eyes down and right	ST' 15 △	LHT' 18 △
Eyes straight	ST' 30 △	LHT' 20 △
Eyes up and left	ST' 25 △	LHT' 20 △
Eyes left	ST' 25 △	LHT' 15 △
Eyes down and left	ST' 20 △	LHT' 25 △

Five months after operation there was still present a slight residual overaction of the left inferior oblique muscle, which produced left hypertropia in eyes directed to the right. The left hypertropia in eyes directed to the left, due to weakness of the right inferior oblique and spasm of the right superior oblique, was well corrected. The measurements were:

Eyes up and right	ST' 5 △	LHT' 5 △
Eyes right	ST' 0 △	LHT' 5 △
Eyes down and right	ST' 0 △	LHT' 5 △
Eyes straight	ST' 0 △	LHT' 8 △
Eyes up and left	ST' 10 △	LHT' 0 △
Eyes left	ST' 5 △	LHT' 0 △
Eyes down and left	ST' 15 △	LHT' 0 △

Pictures before and after operation were attempted several times, but none was successfully taken because of the child's poor cooperation.

Comment.—The mistake of myectomizing the normal right inferior oblique instead of the overactive left inferior oblique muscle might happen to any one. Fortunately, the error was corrected by weakening the direct antagonist of the right inferior oblique, i. e., the right superior oblique.

CASE 9.—Master N. P., aged 4½, had an exotropia of 30 to 50 △, associated with overaction of each superior oblique muscle. In May 1944, the left external rectus muscle was recessed, the left internal rectus was resected and both superior oblique muscles were tenotomized on the nasal border of the superior rectus. After the operation, residual exotropia and right hypertropia persisted, the measurements with prisms being as follows:

Eyes up and right	XT' 3 △	RHT' 17 △
Eyes right	XT' 10 △	RHT' 25 △ (fig. 12 *a*)
Eyes down and right	XT' 18 △	RHT' 30 △
Eyes straight	XT' 15 △	RHT' 20 △ (fig. 12 *b*)
Eyes up and left	XT' 0 △	RHT' 2 △
Eyes left	XT' 7 △	RHT' 2 △ (fig. 12 *c*)
Eyes down and left	XT' 25 △	RHT' 4 △

This operation corrected most of the exotropia and most of the left hypertropia when the eyes were directed to the left; but the right hypertropia in eyes directed to the right, due to overaction of the left superior oblique, remained essentially the same. It was therefore decided to tenectomize the left superior oblique and, at the same time, to resect the left internal rectus. The patient made an excellent postoperative recovery. Two weeks after the second operation there was no hypertropia with the cover test in eyes directed to the right, and there was no clinically discernible weakness of the left superior oblique. The left upper lid drooped a little, owing, presumably, to residual edema fig. 12 *a*.

Two and one-half months after the operation the overaction of the left superior oblique muscle was greatly reduced, as shown by the following measurements with prisms:

Eyes up and right	XT' trace	HT' 0 △
Eyes right	XT' trace	HT' 0 △ (fig. 12 *d*)
Eyes down and right	XT' trace	LHT' trace
Eyes straight	XT' 0 △	HT' 0 △ (fig. 12 *e*)
Eyes up and left	XT' trace	HT' 0 △
Eyes left	XT' trace	LHT' trace (fig. 12 *f*)
Eyes down and left	XT' trace	LHT' 5 △

Comment.—In this case a 5 mm. tenectomy of the left superior oblique reduced the right hypertropia in eyes down and right from 30 △ to a trace of left hypertropia. A questionable weakness of the left superior oblique of less than 5 △ was noted in extreme rotation of the eyes to the right lower field. It was impossible to measure accurately this slight deviation because it did not become discernible until the left eye was carried so far down that it was hidden from view by the nose.

CASE 10.—M. M., a girl aged 15, came to the Vanderbilt Clinic in January 1939 with 6 mm. of congenital ptosis of the left upper lid. Examination showed vision of 20/20 in each eye with orthophoria for distance and near vision. No weakness was noted in either superior rectus muscle. On May 29, 1939 a resection of the left levator palpebrae muscle was done, with slight improvement in the amount of ptosis present. On Dec. 4, 1939 a Parinaud-Young operation for ptosis was done through a conjunctival incision. After this procedure, the ptosis was slightly improved, but a notch in the upper lid formed. On July 8, 1940 the upper border of the tarsus was again sutured to the superior rectus muscle through a conjunctival incision. After the third operation the ptosis was well corrected, but the patient

complained of vertical diplopia. Examination showed pronounced weakness of the left superior rectus, sufficient to produce a right hypertropia of 20 to 30 △ when looking up and to the left. On Dec. 7, 1945 the patient still complained of diplopia and the prism measurements were:

Eyes up and right	XT 22 △	RHT 20 △ (fig. 13 *a*)
Eyes right	XT 19 △	RHT 24 △ (fig. 13 *d*)
Eyes down and right	XT 18 △	RHT 24 △ (fig. 13 *g*)
Eyes straight	XT 11 △	RHT 3 △ (fig. 13 *e*)
Eyes up and left	XT 15 △	RHT 18 △ (fig. 13 *c*)
Eyes left	XT 4 △	RHT 2 △ (fig. 13 *f*)
Eyes down and left	XT 7 △	RHT 2 △ (fig. 13 *i*)

A diagnosis of weakness of the left superior rectus and the left inferior oblique muscle, associated with overaction of the left superior oblique, was made. On Dec. 18, 1945 an incision was made in the upper nasal quadrant of the conjunctiva of the left eye and Tenon's capsule undermined. Considerable scar tissue from the three previous operations was encountered, and the tendon of the superior oblique was picked up and tenotomized with considerable difficulty.

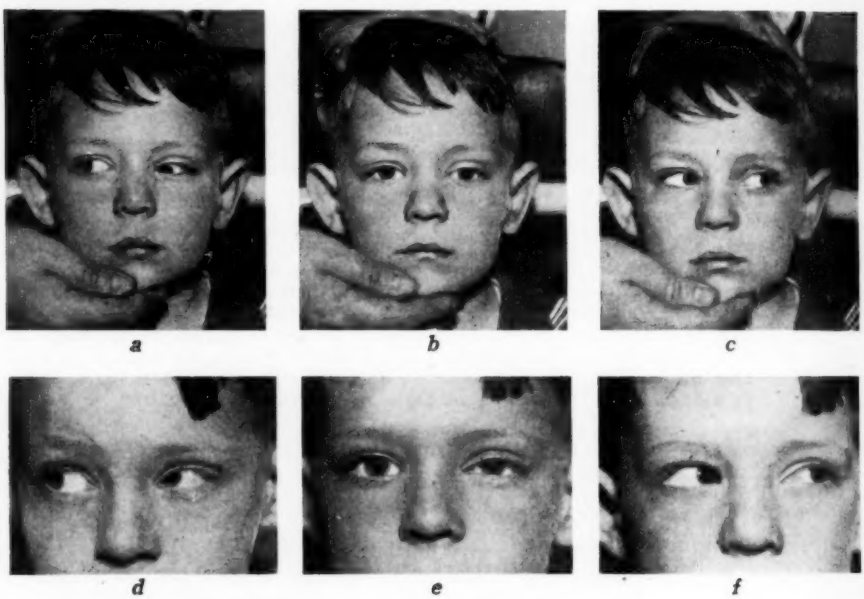


Fig. 12 (case 9)—(*a-c*) Eyes as in figure 7 (*d-f*).

(*a*) Both eyes directed to the right, with the right eye fixing. Note the large amount of left hypotropia present because of overaction of the left superior oblique muscle.

(*b*) Both eyes looking straight ahead. Note the ptosis and the hypotropia of the left eye.

(*c*) Both eyes directed to the left.

(*d-f*) Eyes two and one-half months after tenectomy of the left superior oblique muscle and resection of the left internal rectus muscle.

(*d*) Both eyes directed to the right. Note the pronounced improvement in the left hypotropia after operation.

(*e*) Both eyes looking straight ahead. Note the residual ptosis and absence of left hypotropia.

(*f*) Both eyes directed to the left. Note that in this case tenectomy of the left superior oblique did not affect the muscle balance in this position.

The operation on the left superior oblique muscle greatly reduced the vertical deviation (fig. 13) in the entire lower field, so that the patient no longer had spontaneous diplopia here. However, diplopia could be induced by covering one eye with a red glass. Diplopia fields showed a considerable reduction of the vertical diplopia in the field of action of the once overactive left superior oblique muscle (fig. 14).

Comment.—The diplopia and weakness of the elevator muscles (superior rectus and inferior oblique) of the left eye in this case developed after the operation for relief of ptosis and was due most likely to the weight of the upper lid. The patient had fusion only in a small area in the field of action of the left inferior rectus muscle. Therefore, operation to cure the diplopia should avoid this muscle. Because the lower fields of vision are more important in everyday life and because she had diplopia in the field of action of the left superior oblique muscle, weakening of this muscle was indicated. The postoperative result was gratifying.

CASE 11.—Mrs. A. L., aged 57, had had a crossed right eye since infancy. Vision in the right eye had been poor all her life and could not be improved beyond 20/200 with glasses. Vision in the left eye was 20/20 with a correction for weak compound hyperopia. The patient had exotropia for distance and near vision associated with an overaction of each superior oblique muscle. For 20 feet the deviation measured 40 △ of exotropia and 10 △ of left hypertropia. For 16 inches the exotropia was 50 △ and the left hypertropia 10 △. The prism measurements in the different directions of gaze were:

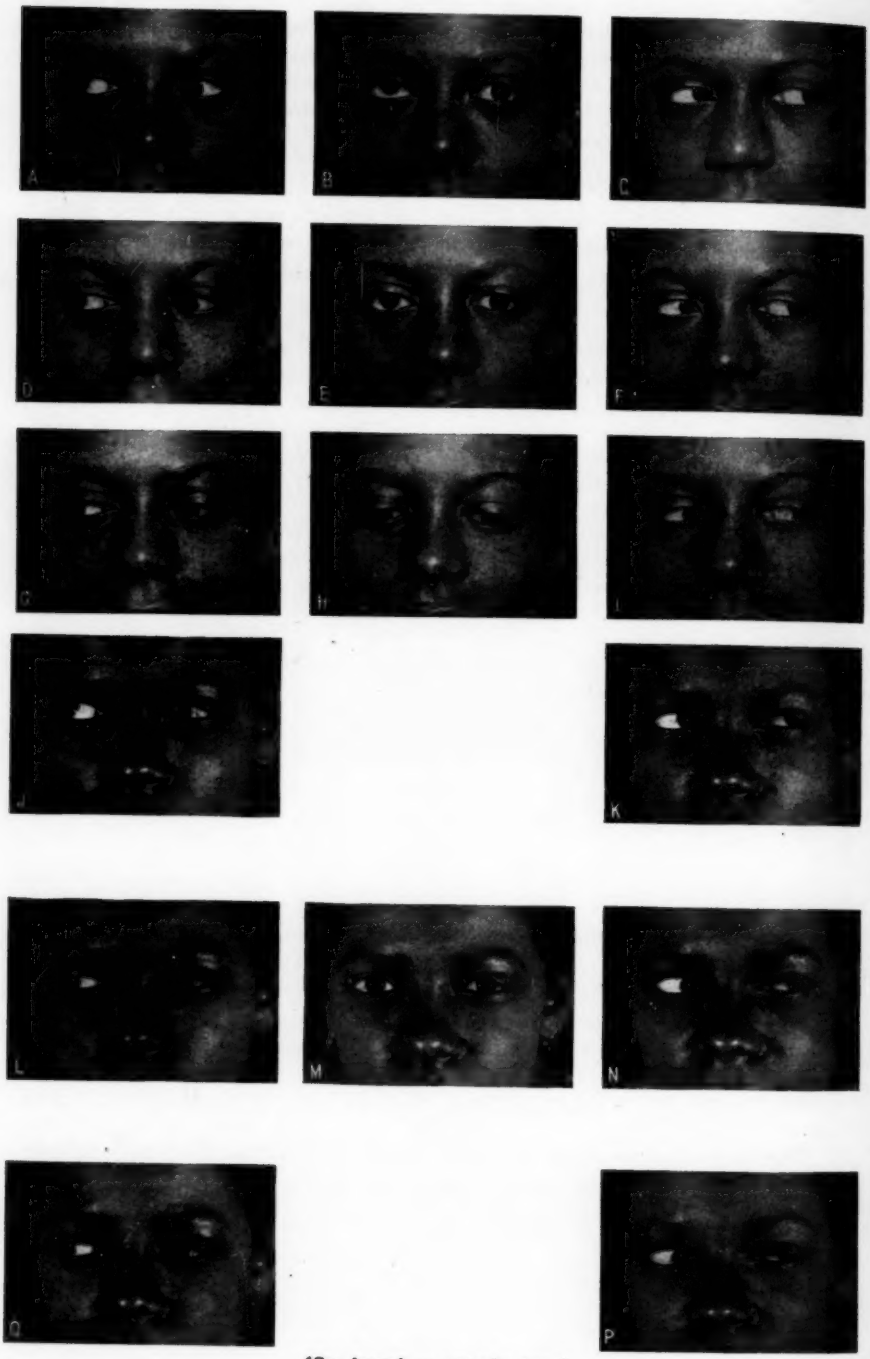
Eyes up and right	XT′ 55 △	RHT′ trace
Eyes right	XT′ 50 △	RHT′ 8 △
Eyes down and right	XT′ 45 △	RHT′ 15 △
Eyes straight	XT′ 50 △	LHT′ 10 △
Eyes up and left	XT′ 55 △	LHT′ trace
Eyes left	XT′ 50 △	LHT′ 5 △
Eyes down and left	XT′ 45 △	LHT′ 10 △

On March 25, 1946 both superior oblique muscles were tenectomized (the left 6 to 7 mm. and the right 5 mm.); the right external rectus muscle was recessed 7 mm., and the right internal rectus muscle was resected 9 mm. One month after the operation the right hypertropia in eyes directed down and to the right (due to overaction of the left superior oblique muscle) was reduced from 15 to less than 5 △. The left hypertropia in eyes directed down and to the left (due to overaction of the right superior oblique muscle) was changed from a left hypertropia of 10 △ before operation to a right hypertropia of 6 to 9 △. The right hypertropia in eyes directed down and to the left was due to an induced weakness of the right superior oblique muscle.

When last seen two months after the operation, her extraocular muscle balance in the six cardinal directions of gaze were:

Eyes up and right	XT′ 15 △	LHT′ 6 △
Eyes right	XT′ 0 △	LHT′ 8 △
Eyes down and right	ST′ 15 △	LHT′ 0 △
Eyes straight ahead	XT′ 15 △	LHT′ 0 △
Eyes up and left	XT′ 20 △	HT′ 0 △
Eyes left	XT′ 20 △	LHT′ 5 △
Eyes down and left	XT′ 0 △	HT′ 0 △

For distance she had 6 △ of exotropia and 2 △ of left hypertropia.



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CASE 12.—M. R., a girl aged 2½, had a pronounced head tilt, with the occiput on the right shoulder and with her eyes turned to the left. In this position she obviously saw single. She was an "instrument baby" and had what her physician called a premature synostosis of the cranial sutures—a congenital dysplasia of the skull. This condition produced extreme asymmetry of the face, head and orbits. The head tilt was attributed to paresis of some of the extraocular muscles, due to the distortion of the orbits.

Ocular examination showed that the child had good fixation in each eye. Careful measurement of the excursions of the extraocular muscles in the cardinal directions of gaze was virtually impossible because of the patient's age. There was present, beyond any doubt, weakness of the right superior rectus muscle with pronounced overaction of the contralateral inferior oblique muscle. This was most prominent in eyes directed up and to the right. In eyes directed up and to the left, there was moderate weakness of the right inferior oblique muscle with moderate overaction of the contralateral superior rectus muscle, especially when the right eye was used for fixation. In eyes directed down and to the left there was moderate overaction of the right superior oblique, secondary to weakness of the homolateral inferior oblique muscle. This case, therefore, was one of weakness of the elevator extraocular muscles of the right eye with secondary overaction of the left inferior oblique, left superior rectus and right superior oblique muscles.

At operation, the right superior oblique muscle was tenectomized 5 mm., and the left inferior oblique muscle was myectomized 5 to 6 mm. Nothing was done to the other extraocular muscles. Five weeks after the operation moderate overaction of the left inferior oblique and slight residual overaction of the right superior oblique muscle persisted. The elevating power of the paretic right inferior oblique muscle had been perceptibly increased by weakening the power of its direct antagonist. The head tilt was less pronounced but still present. At a later date a recession of the left inferior oblique muscle may have to be done.

Fig. 13 (case 10).—(*A*) Both eyes directed up and to the right. Note the left hypertropia, owing to weakness of the left inferior oblique muscle. (*B*) Both eyes directed straight up. Note the weakness of elevation of the left eye. (*C*) Both eyes directed up and to the left. Note the left hypotropia, owing to weakness of the left superior rectus muscle. (*D*) Both eyes directed to the right. Note the left hypotropia, owing to weakness of the left inferior oblique and overaction of the left superior oblique muscle. (*E*) Both eyes directed straight ahead. (*F*) Both eyes directed to the left. (*G*) Both eyes directed down and to the right. Note the left hypotropia, owing to overaction of the left superior oblique. (*H*) Both eyes looking straight down. (*I*) Both eyes looking down and to the left. This was the only position of gaze in which she had single binocular vision. In all other positions she saw double. (*J-P*) Eyes after tenotomy of the left superior oblique muscle. (*J*) Both eyes directed up and to the right. Some weakness of the left inferior oblique muscle still persists. Compare with *A*. (*K*) Both eyes directed up and to the left. (*L*) Both eyes directed to the right. The patient did not have spontaneous diplopia in this field. Compare with *D*. (*M*) Both eyes straight ahead. Compare with *E*, and note that the left eye is higher in *M*. (*N*) Both eyes directed to the left. (*O*) Both eyes directed down and to the right. The patient still had some residual overaction of the left superior oblique (compare with *G*), but had no spontaneous diplopia in this position. (*P*) Eyes directed down and to the left.

Comment.—In this case the overaction of the right superior oblique was secondary to weakness of its direct antagonist—the right inferior oblique muscle. Tenectomy of the right superior oblique definitely increased the elevating power of the right inferior oblique without producing a manifest weakness of the former.

Case 13.—J. B., a youth aged 16, came to the Vanderbilt Clinic in April 1946 because his eyes had been crossed since he had measles in childhood. Examination

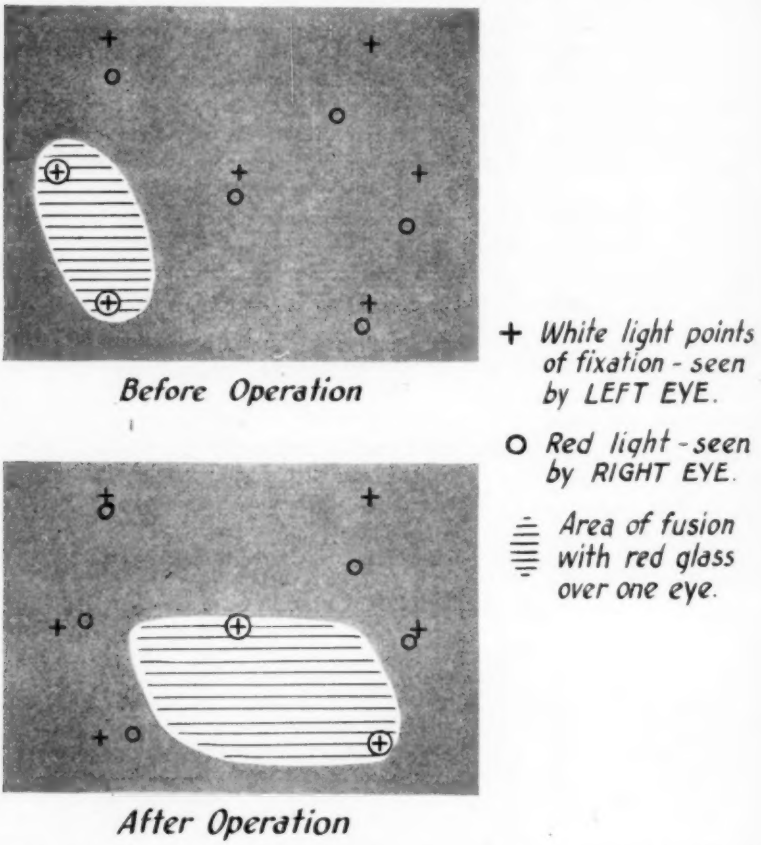
Before Operation
After Operation
+ White light points of fixation - seen by LEFT EYE.
O Red light - seen by RIGHT EYE.
Area of fusion with red glass over one eye.

Fig. 14 (case 10)—Fields for diplopia before and after operation. A red glass was held over the right eye; the patient sat 75 cm. from the tangent screen, and each reading was taken 75 cm. from the central point of fixation. This rotated the eyes 45 degrees from the primary position into the six cardinal directions of gaze. Note that the diplopia was less in the right lower field (field of action of the left superior oblique) and that the patient had fusion over a wider area after operation.

showed vision to be 20/20 in the right eye and 20/40 in the left eye, which was improved to 20/20 and 20/30 respectively with glasses. For distance his deviation measured 21 △ of esotropia and 22 △ of left hypertropia, and for near vision the

near point of convergence was almost to the point of his nose (50 mm.). His fundi were normal. No ptosis was present. Prism measurements for near vision were as follows:

Eyes up and right	ST' 16 △	LHT' 30 △
Eyes down and right	ST' 25 △	LHT' 40 △
Eyes straight	ST' 24 △	LHT' 30 △
Eyes up and left	ST' 16 △	LHT' 18 △
Eyes down and left	ST' 25 △	LHT' 30 △

In eyes directed up and to the right there was weakness of the right superior rectus muscle with overaction of the contralateral inferior oblique muscle. In eyes directed up and to the left there was definite weakness of the right inferior oblique muscle with overaction of the left superior rectus, especially with the right eye fixating the muscle light. In eyes directed down and to the left there was pronounced overaction of the right superior oblique muscle. In eyes directed down and to the right there was pronounced left hypertropia, due to contraction of the left inferior rectus or to weakness of the left superior oblique muscle. In short, this patient presented the findings characteristic of weakness of the elevator extraocular muscles (superior rectus and inferior oblique) of the right eye with overaction of the associated yoke and direct antagonist muscles.

On April 4, 1946 the right superior oblique muscle was tenectomized 5 mm. At the same time, the left internal rectus was recessed, the left external rectus resected and the left inferior oblique myectomized.

After operation the horizontal deviation was moderately overcorrected, with some weakness of the left internal rectus muscle. In eyes directed down and to the left (the field of action of the right superior oblique) the vertical deviation was reduced by the operation on the superior oblique muscle from 30 to 0 △. The prism measurements on the ninth postoperative day were:

Eyes up and right	XT' 60—△	RHT 5 △
Eyes right	XT' 55 △	HT' 0 △
Eyes down and right	XT' 55 △	LHT' 14 △
Eyes straight	XT' 34 △	LHT 0 △
Eyes up and left	XT' 25 △	LHT 16 △
Eyes left	XT' 20 △	LHT 5 △
Eyes down and left	XT' 11 △	HT 0 △

The patient has not been seen since.

Comment.—The vertical deviation in eyes directed down and to the left (field of action of the right superior oblique) was reduced from 30 to 0 △ by the tenotomy of the right superior oblique muscle. This result was considered excellent. The myectomy of the left inferior oblique reduced the left hypertropia for near, in eyes directed up and to the right, from left hypertropia of 30 to right hypertropia of 5 △.

GENERAL COMMENT

It is difficult to evaluate accurately the effect of any operation on the elevator muscles of the eye because the amount of vertical deviation present before and after operation varies with the position of the eyes

in adduction or abduction in the horizontal plane, as well as with the amount of elevation or depression of the eyes from this plane.

Since the amount of deviation produced by overaction of the right superior oblique, for example, varies from a position of eyes directed to the left to a position of eyes directed down and to the left, being less in the former and greater in the latter, it was decided to tabulate the amount of deviation in these two positions before and after operation to determine just how much correction had actually been achieved by the operation. In all these cases it was noted that the greater amount of correction occurred in the field of greatest action of the superior oblique muscle. The patients were divided into three groups. Group 1 comprised 4 patients with simple tenotomy lateral to the superior rectus muscle; group 2 was made up of 6 patients with simple tenotomy on the nasal side of the superior rectus muscle, and group 3 was composed of 10 patients with tenectomy on the nasal side of the superior rectus muscle.

In group 1 there were 2 complete failures, 1 partial success and 1 good result. In the patient with a good result (case 4) a left hypertropia in eyes directed down and to the left was reduced from an estimated hypertropia of 25 Δ to a hypertropia of about 5 Δ. The poor showing in this group was attributed partly to timidity and lack of experience on the part of the surgeon, but mostly to the fact that one can never be enirely sure that all the fibers of the superior oblique muscle have been completely freed from the globe when the tenectomy is done lateral to the superior rectus muscle.

In group 2 there were 2 failures. The failures were attributed to cutting the sheath of the superior oblique muscle rather than its tendon. Once one has seen the pearly white, glistening tendon of the superior oblique muscle, one will never again confuse it with the sheath, which, by comparison, is white and semitendinous. Failure to cut the tendon will certainly produce no correction. Of the 4 remaining patients, each had from 13 to 15 Δ of correction in the field of greatest action of the superior oblique muscle.

In group 3 there were 10 tenectomies of the superior oblique muscle with not a single failure. The amount of correction in the field of greatest deviation varied from 10 to 30 Δ for a tenectomy of 5 to 7 mm., with an average correction of 21 Δ for the group as a whole. Two patients (cases 9 and 13) obtained 30 Δ of correction from a 5 mm. tenectomy, while 1 patient (case 11) had 10 Δ of correction with a 5 mm. tenectomy on the right eye and 15 Δ of correction from a 7 mm. tenectomy on the other eye. In cases 9 and 13 there was a pronounced overaction of the superior oblique (30 Δ), while the overaction in the other cases, in which the amount of correction was less, was also less pronounced. This may mean that a 5 mm. tenectomy of the superior oblique, according to

the technic described here, will produce from 10 to 30 △ of correction, depending on the amount of overaction of the muscle. This series of cases is entirely too small to justify a dogmatic statement about how much correction a 5 mm. tenectomy will produce in a given case. Only time and more experience will give the correct answer.

It is interesting to note that more than one-half the cases reported here were associated with an exotropia, which increased in eyes directed down and decreased in eyes directed up. If esotropia was present, the esotropia decreased in eyes directed down. This behavior was attributed to the abducting power of the superior oblique muscles in the lower fields. It is interesting to recall that just the opposite occurs with bilateral overaction of the inferior oblique muscle; i.e., the esotropia becomes less in eyes directed upward and greater in eyes directed down. In 5 of this series of cases there was bilateral congenital overaction of the superior oblique muscle; in 3 cases the overaction was unilateral and congenital; in 2 cases it was secondary to injudicious surgical procedures on the direct antagonist (the unilateral inferior oblique), and in 2 cases the overaction was first discovered after previous operation on one or more of the extraocular muscles other than the inferior oblique.

SUMMARY

Overaction of the superior oblique muscle may be congenital or acquired in origin. As a cause of hypertropia, it is second in frequency only to overaction of the inferior oblique muscle. It may cause ocular discomfort, headaches, reading difficulties, vertical diplopia, head tilting and torsional difficulties. It is characterized by a vertical deviation which increases in adduction and in the lower temporal fields.

Overaction of the superior oblique muscle is best treated by tenotomy or tenectomy of the offending muscle. This operation is best done under Tenon's capsule on the nasal side of the superior rectus according to the technic already described. For adults local anesthesia is sufficient. For children a general anesthesia is necessary. Simple tenotomy will produce from 5 to 10 △of correction. A tenectomy will produce from 10 to 30 △ of correction, depending on the amount of tendon removed and the amount of overaction present. This operation does not produce paralysis if the sheath is not severed along with the tendon.

In the past nine years, 20 tenotomies or tenectomies were done on 13 consecutive patients. In none of these patients was a discernible weakness of the superior oblique muscle produced. In 4 out of 10 tenotomies the tendons were presumably incompletely severed and the results were unsatisfactory. In all the tenectomies the result was good.

CONCLUSIONS

1. Tenotomy or tenectomy of the superior oblique muscle is a simple, effective and reliable procedure for the treatment of hypertropia associated with overaction of this muscle.

2. This procedure does not produce paralysis of the superior oblique muscle, nor does it produce any other complication.

3. The amount of correction needed in each individual case can be graded by varying the amount of tendon removed.

4. This operation is best done on the nasal side of the superior rectus muscle under Tenon's capsule according to the technic described.

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IONTOPHORESIS WITH CONTACT LENS TYPE AND EYECUP ELECTRODES

Some Points of the Theory and Technic of Ion Transfer

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IONTOPHORESIS (ion transfer, ionization) has been employed in general medicine for over one hundred years. Although it has been used in the treatment of diseases of the eye for more than fifty years, it is still a comparatively unknown form of ocular therapy. From three to fifteen times greater concentrations of drugs can be obtained in the tissues of the conjunctiva, cornea and anterior segment of the eye by iontophoresis than by the topical application of the same drugs. For this reason mydriasis can usually be obtained by the iontophoretic introduction of atropine sulfate in the case of pupils that are refractory to the topical application or the subconjunctival injection of mydriatics. Anterior synechias may also be broken by this method when other methods fail. The theories and experimental and clinical data of iontophoresis as they apply to general medicine are thoroughly discussed by Abramowitsch and Neoussikine [1] in their book on "Treatment by Ion Transfer." In this paper only my apparatus, the theory of ion transfer, and some technical points applicable to ocular iontophoresis are discussed.

There are several reasons why iontophoresis has not been employed in ophthalmology as extensively as it should be. One of these reasons is that exaggerated claims have been made for the value of this form of therapy. Such claims naturally make the conservative ophthalmologist unwilling to try the method, particularly if it seems somewhat complicated to carry out. Another reason is that it is difficult to get a clear idea of the theories involved in iontophoresis from textbooks or from the contemporary literature (both domestic and foreign). The result of this is that the novice may apply the medicament to the wrong electrode and under these conditions does not succeed in introducing the proper fraction of the drug into the tissues. Now that the importance of obtaining high concentrations of the sulfonamides, penicillin and other antibiotic drugs in the tissue in the treatment of certain inflammations of the cornea and anterior segment of the globe is recognized,

1. Abramowitsch, D., and Neoussikine, B.: Treatment By Ion Transfer (Iontophoresis), New York, Grune & Stratton, Inc., 1946.

iontophoresis is likely to be more extensively employed. Another reason for the neglect of this form of therapy in ophthalmology is the difficulty of obtaining the proper equipment to carry out this procedure. The zinc and other metallic eye applicators frequently used, although covered with cotton or felt, may cause abrasions of the cornea, especially when treatment has to be carried out on several successive days.

With the aid of the House of Vision,[2] I have devised an apparatus and applicators that are simple to use and do not endanger the cornea. Many of the best features of the apparatus and of the electrodes have been a part of similar equipment used by different oculists for a long time. The combination of all these desirable features seems to make the apparatus particularly adaptable for use in ophthalmology. The apparatus is also equipped with an electrode for use in the electrolytic epilation (electrolysis) of misdirected cilia and the destruction of small papillomas, telangiectases and other small growths of the lids and of the conjunctiva by electrolysis.

The apparatus consists of a portable box measuring 11 inches (27.9 cm.) in length, 8¼ inches (20.9 cm.) in width, and 7 inches (17.7 cm.) in depth. It is powered by replaceable B batteries connected by a voltage regulator to a voltmeter, which registers from 0 to 50. With ordinary use the batteries should be good for over a year. An ohm resistor is connected through a rheostat to a milliammeter which registers from 0 to 5 milliamperes. In the upper left hand corner of the panel is an automatic pushbutton which turns the current on when the lid of the box is opened. The voltmeter is on the left hand side of the middle of the panel. Below it is a switch which turns to the right to increase the voltage from 6 to 12, 24 and 48. To the right of the voltmeter is a milliammeter, controlled by a switch just below it. The switch is turned clockwise (to the right) to increase the amperage. In the lower left hand corner are two posts for plugging in the wire or wires for the negative pole (cathode), while the lower right hand corner has two red posts for plugging the wire or wires into the positive pole (anode). The connecting wires and active electrodes are in separate compartments at the back of the instrument. These compartments are covered by a felt pad. The indifferent aluminum hand electrode measures 9 inches (22.8 cm.) in length and ⅞ inch (2.1 cm.) in diameter. It fits into a groove on the inner surface of the cover of the box.

The hand electrode has the advantage over the usual flat leadfoil electrodes applied to the nape of the neck and other parts of the body in that there is no burning sensation at the place of contact with the skin. It avoids the electrical stimulation of the brain, sometimes evidenced by vertigo and headaches, which may follow iontophoresis when one

2. Distributors, The House of Vision, Chicago.

electrode is applied to the eye and the other to the nape of the neck. For special purposes, such as animal experiments, 5 × 7 inch (12.7 × 17.7 cm.) flat electrodes may be substituted for the hand electrode. Only one insulated wire need be attached to it. The hand electrode, too, may be used with only one insulated wire plugged into one end of it. The contact, however, is much better when one wire is inserted at each end of the hand electrode, the other end of each wire being connected to the proper pole on the instrument panel. The double connection of the hand electrode and its greater length, permitting it to be grasped by both hands, make this electrode different from other hand electrodes hitherto employed.

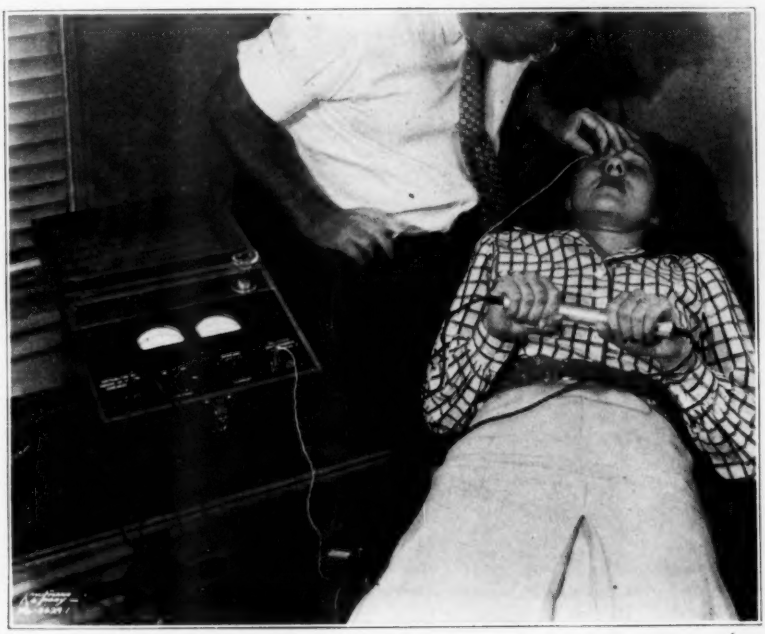

Fig. 1.—Iontophoresis with contact lens electrode. Note eyecup electrode on instrument. The patient is holding the hand electrode.

The active electrodes are made of "lucite" (methyl methacrylate). One of them consists of a contact lens base with a narrow chimney extending from its center. Five millimeters above the corneal portion is a circular piece of platinum wire, partially embedded in the lower portion of the funnel. This is connected to an insulated flexible wire. (Stoker [3] devised various glass electrodes that can be applied to the eye.

3. Stoker, cited by Schnyder, W. F.: Iontophorese in Ophthalmologie, Klin. Monatsbl. f. Augenh. **63**:433, 1919.

These electrodes, as well as Birkhäuser's [4] glass electrode, are not of the contact lens variety. Van Heuven [5] devised a contact lens electrode made of glass. From the center of the corneal contact lens base a narrow stem extends forward. This broadens into a wide ampulla which has two openings, a wide lateral one for the introduction of a spiral metal electrode and a narrow one at the apex of the ampulla through which the medicament is injected into the ampulla with a syringe. Von Sallmann [6] uses a Van Heuven electrode made of "lucite.") The other applicator consists of an eyecup, also made of plastic. At the bottom of the cup is a platinum wire connected to a thin insulated cord. Eye applicators made of glass have been described before. Plastic eyecup electrodes and hollow stem eyecup electrodes with removable base have not been described before, as far as I know. The stem of the eyecup is

Fig. 2.—Contact lens electrode. A circular platinum wire is on the inner surface, just above the junction of the wide scleral portion with the narrow chimney of the electrode (inner diameter of chimney 8 mm.). The oval plastic plate on the left side of the chimney covers the area of junction of the flexible connecting wire (to pole of battery) with the platinum electrode.

hollow, the base fitting into the stem like a ground glass stopper into a bottle. This arrangement permits the use of this electrode like an ordi-

4. Birkhaüser, R.: Experimentelles und Klinisches zur iontophoretischen Behandlung von Hornhauttrübungen mit der Röhrenelektrode, Klin. Monatsbl. f. Augenh **67**:536, 1921.

5. van Heuven, J. A.: Ueber Glaukosan-Iontophorese, Arch. f. Augenh. **106**:625, 1932.

6. von Sallmann, L.: Penicillin and Sulfadiazine in the Treatment of Experimental Intraocular Infections with Staphylococcus Aureus and Clostridium Welchii, Arch. Ophth. **31**:58 (Jan.) 1944, footnote 16.

nary eyecup, that is, filled with the solution and then inverted over the eye, or placed on a table with the patient leaning over until the eye is immersed in the solution. In patients who have to lie on their back and on whom the contact lens electrode cannot be used the base of the cup is removed; the cup is placed over the eye and filled with solution through the hollow tubular stem of the cup. The iontophoresis then proceeds as explained in the section on the technic of iontophoresis.

The active electrode employed in electrolysis for the epilation of misdirected eyelashes and for the destruction of small growths of the lids or conjunctiva consists of a fine steel needle. There is a fine blunt

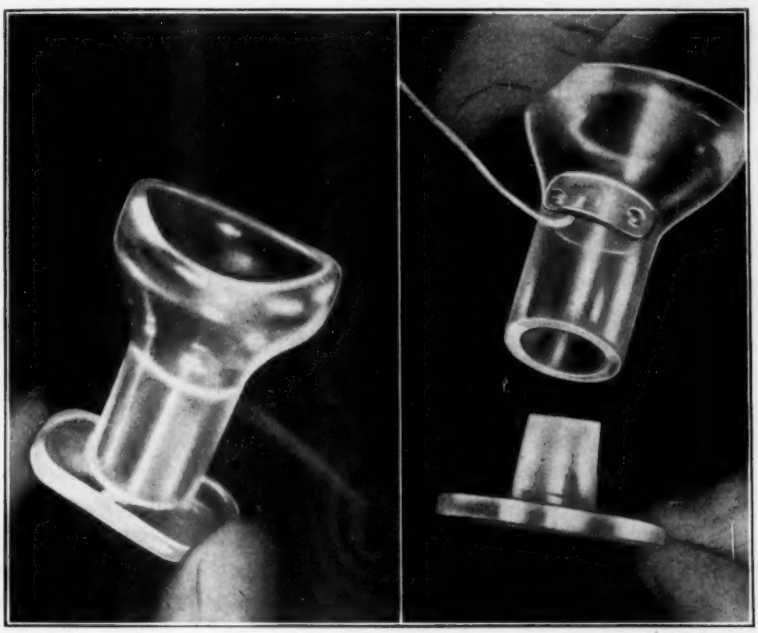

Fig. 3.—*A*, Plastic eyecup electrode ready for use as a conventional eyecup electrode. The white line at the base of the flaring portion of the eyecup indicates the partially embedded circular platinum electrode on the inner surface of the cup. *B*, the electrode with the base removed. The base fits into the hollow stem like a ground glass stopper into a bottle. The connection of the flexible connecting wire with the platinum wire electrode is protected by the oval plastic plate near the neck of the eyecup.

needle for removal of hairs and a slightly heavier pointed needle for the treatment of papillomas, etc.

SOME THEORETIC CONSIDERATIONS OF IONTOPHORESIS

Some of the molecules of salts, acids and bases when dissolved in water, undergo dissociation or ionization. The less concentrated the solution, the more molecules become dissociated into ions. These ions are

electrically charged. The electropositive ions are called cations because they are attracted to the negative pole or cathode during electrolysis. The electronegative ions or anions are attracted to the positive pole or anode. It is thus seen that the two kinds of ions are designated by the pole to which they are attracted rather than by the electric charge which they carry. In an aqueous solution of acids some molecules dissociate into positive hydrogen ions and negative acid radical ions. In a salt solution the dissociation is into positive metal ions and negative acid radical ions. In a solution of a base the dissociation is into positive ions of a metal and negative hydroxyl ions. When the electric current of a battery is turned on, one electrode receives a positive charge, the other receives a negative charge. The direction of the flow of the current is from the positive pole (anode) toward the negative pole (cathode). If the current passes through an electrolyte (that is, through aqueous solutions of substances that conduct electricity), the electropositive ions or cations travel toward the negative pole or cathode. The anions or electronegative ions are attracted toward the positive pole or anode.

In order to drive the proper ions into the tissues, one should know whether one wants to carry the ions with the positive or with the negative electric charge into the tissues. The electrodes are then arranged in such a way that the flow of the current is through the tissues of the eye toward the indifferent electrode held in the hands. This means that the eye electrode is at times connected to the positive pole of the instrument, at times to the negative pole, depending on the substance used for iontophoresis. Thus when atropine sulfate is used for iontophoresis, the purpose is to have the electropositive atropine ions go through the cornea toward the indifferent hand electrode. Since the flow of current is from the positive pole toward the negative pole, the wires of the hand electrode must be connected to the negative pole of the instrument and the active electrode (eye applicator) to the positive pole. In this way the positive charged atropine ions pass through the eye toward the negative pole, to which they are naturally attracted. If the electrodes were connected in an opposite manner, the sulfate ions would penetrate through the cornea while the atropine ions would be repelled. In the case of sodium sulfathiazole the eye applicator filled with this solution is attached to the negative pole while the hand electrode is connected with the positive pole of the battery set. If the eye applicator were attached to the positive pole, the positively charged sodium ions would penetrate the cornea on their way toward the negatively charged hand electrode while the negatively charged sulfathiazole ions would be repelled from the cornea. In other words, in order to cause electropositive ions to enter the eye, the eye electrode must be connected with the positive pole. For electronegative ion transfer, the eye electrode is connected with the negative pole. This arrangement of the electrodes permits the proper ions to pass

through the eye toward the opposite (hand) electrode, to which they are attracted.

A partial list follows of substances arranged in accordance with the proper connections of the eye electrode to the poles of the battery in order to cause penetration of the therapeutically effective ions into and through the cornea.

Eye Electrode Connected With Positive Pole (Anode)

Atropine sulfate
Physostigmine salicylate
Pilocarpine nitrate
Acetylcholine chloride or bromide
Carbaminoylcholine chloride
Acetyl beta methylcholine chloride
Streptomycin hydrochloride or sulfate
Quinine bisulfate, hydrochloride, and other salts of quinine
Epinephrine hydrochloride
Copper sulfate and other salts of copper
Zinc sulfate
Histamine
Calcium chloride and lactate

Eye Electrode Connected With Negative Pole (Cathode)

Penicillin sodium and penicillin calcium
Sodium sulfathiazole and other sodium salts of the sulfonamides
Potassium iodide and other salts of iodine
Sodium chloride
Sodium salicylate

CONCENTRATION OF SOME SOLUTIONS USED FOR IONTOPHORESIS

Since iontophoresis causes a concentration of ions in the tissues and also prolongs the action of drugs, only weak solutions should be used. The following concentrations of the drugs have been found effective by different authorities: penicillin, 1,000 Oxford units per cubic centimeter; sulfonamide drugs, 5 per cent; atropine, 0.25 per cent; pilocarpine, 0.1 per cent; acetylcholine, 1 : 400; quinine salts, 0.5 per cent; calcium salts, 0.5 per cent; epinephrine, 1 : 20,000; zinc sulfate, 0.25 per cent.

SOME POINTS ON TECHNICS OF IONTOPHORESIS

Ordinarily no topical anesthesia is necessary. In patients who have highly inflamed eyes and in those who are very apprehensive, as well as in children, the eye may be anesthetized by the instillation of a drop of tetracaine hydrochloride, 0.5 per cent solution, or some similar topical anesthetic. I have used the contact lens electrode on small children, the youngest a child of 18 months of age, after topical anesthesia with tetracaine hydrochloride. When the contact lens electrode is used, the patient should lie flat on his back. The hand electrode, into each end of which an insulated cord has been inserted (the other ends of the cords having

been plugged into the positive or negative poles of the instrument, as indicated by the medicine to be used—for details see the preceding paragraphs), is grasped firmly with both hands by the patient. The lids are separated and, with the patient keeping both eyes open and looking straight up at the ceiling, the applicator is inserted between the lids so that the broad base comes to lie on the sclera around the cornea. The lids are then released. The patient is instructed to keep both eyes open and to look straight up throughout the treatment. In this way the cornea will not be touched by the applicator. The insulated cord to which the eye applicator is attached was previously plugged into the proper pole of the battery. The medicament to be used is then poured into the chamber of the electrode with a medicine dropper. The platinum wire must be kept immersed in the solution. It is best to fill the chimney to the top, as some fluid might escape around the base of the electrode during the treatment. The electrode is steadied by the operator while the treatment is being given. If there is some escape of fluid, more medicine is added and slight downward pressure is made on the electrode to prevent further seepage around the base. The switch controlling the voltmeter is turned to number 24 on the panel and the switch controlling the milliammeter is turned slowly to the right, in the direction of the arrowhead, until 1½ or 2 milliamperes is registered on the dial. If not enough current is available, the milliammeter switch is turned back to the left as far as it will go and the voltmeter switch is advanced to 48 volts. The milliammeter switch is now again turned slowly until the desired milliamperage is obtained. One should not go beyond 2 milliamperes. If the battery should be low, the current can be stepped up by placing a piece of cotton, moistened in salt solution or in tap water (distilled water is a nonconductor), over the hand electrode. At the end of the treatment the voltmeter and milliammeter switches are slowly turned back to zero and the electrode is removed from the eye, the content of the eye applicator being mopped up with cotton.

The eyecup electrode is used when the contact lens electrode cannot be employed for some reason, such as excessive apprehension on the part of the patient, deformity of the globe, concomitant inflammations of the lids, etc. It is also useful in treating conjunctivitis and blepharitis through the closed lids. For treatment of the cornea or of the intraocular structures the lids should be kept open so that the cornea is immersed in the solution during the treatment. In ambulatory patients the cup is filled with the solution and placed over the eye in the manner of the ordinary eyecup; that is, the cup is placed on a table and the patient bends his head until the eyecup fits over the orbit, or he holds the eyecup in his hand and bends over until the eye is immersed and then, pressing the cup to the orbit, tilts his head back. In patients who have to lie on their back and on whom the contact lens electrode cannot be used, the base

of the cup is removed, and the cup is placed over the eye and filled with solution through the hollow stem. The arrangement of the hand electrode and control of the current are the same as when the contact lens electrode is used. The period of treatment should not exceed two to five minutes. Treatments may be repeated daily or every second day for four or five treatments.

Occasionally a slight clouding of the cornea may develop after iontophoresis. This usually clears up within a few hours. No bandage or medication is necessary after treatment, unless indicated by the underlying pathologic process.

The "lucite" electrodes should be sterilized before and after being used. They should not be boiled as heat softens them. Alcoholic solutions cause them to become cloudy. They may be sterilized by immersion for twenty minutes in aqueous merthiolate, aqueous "metaphen" (nitromersol), or 1:1,000 "zephiran" (benzalkonium chloride).

ELECTROLYSIS FOR MISDIRECTED LASHES; DESTRUCTION OF SMALL GROWTHS ON THE LID AND CONJUNCTIVA

For misdirected lashes and small growths the active electrode, consisting of a fine steel or platinum needle, is connected, by a flexible, insulated cord, to the negative pole of the instrument. The indifferent hand electrode is connected to the positive pole by the two cords which are plugged into the ends of the electrode. The lid should be anesthetized by infiltration of procaine-epinephrine under the skin for electrolysis of eyelashes, and also along the adjacent fornix if the tarsus is to be treated. A binocular loupe should be worn by the operator, particularly when the follicles of eyelashes are being destroyed. The needle (the fine blunt needle is preferable) is introduced into the hair follicle along the shaft of the eyelash and the current is turned on by setting the switch of the voltmeter at 48. The milliammeter switch is then slowly turned until 2 to 4 milliamperes are registered. The needle is left in place for thirty to forty-five seconds or until hydrogen bubbles are seen around the mouth of the hair follicles. The current is then turned off, and the needle is removed. The hair should lift out with epilation forceps without any resistance. If resistance is met, the needle should be reintroduced into the hair follicle and the current turned on again.

Small growths are treated in the same manner. The sharp pointed needle is introduced in several areas, depending on the size of the growth, and each one coagulated as already described. It may take a week or two before the shrunken growth disappears completely. It is better to repeat the electrolysis several times than to destroy too much tissue.

104 South Michigan Avenue.

NEUROFIBROMATOSIS IRIDIS (RECKLINGHAUSEN'S DISEASE)

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WITH the present report of 2 cases is given a short survey of neurofibromatosis (Recklinghausen's disease) with signs referable to the iris.

REPORT OF CASES

CASE 1.—I. C., a youth aged 16, from Fefar Sabah, came to the clinic on May 5, 1945, complaining of an itching sensation in the eyes, like that of vernal conjunctivitis. Routine examination with the slit lamp revealed mixed gray and brown granules in the iris. The nodules varied in size; some were globular and others flat. Except for these formations in the iris, there were no pathologic changes in the eyes. Vision was 6/6 in each eye. On other portions of the body, e. g., the neck, trunk and extremities, there were pigmented areas of various sizes, some of them being confluent brown spots. No changes were demonstrable in the bones or the skull.

CASE 2.—S. G., a youth aged 15, from Kefar Chassidim, was seen on May 24, 1946, with the complaint of poor sight in his right eye. The squareness of his skull struck the eye at once. The boy's appearance, like his voice, gave the impression that he was older than his age. His body was small, as though pressed together, and the bones were coarse. Examination of the eyes revealed a cicatricial trachoma without corneal complications. On the right side there were slight ptosis with enophthalmos and miosis (Horner). In the iris of each eye were many nodules, of various sizes and color, from cafe au lait to dark brown, with several telangiectases on the surface; some of the nodules were confluent. The pupil of the right eye reacted to light. The lens was almost entirely opaque.

Vision was limited to perception of hand movements at 0.5 meter. Light projection was prompt in all directions. The left eye presented no abnormalities except for the neurofibromatosis of the iris. Vision was 6/6. Tension in the right eye was somewhat reduced as compared with that in the left eye. The Wassermann and Mazzini reactions of the blood were negative. Many pigmented areas were noted on the neck, the body and the arms, varying from the size of freckles to that of the palm, especially in the left submammary region, where a large, fibroma-like swelling was present under the skin. In addition, the patient presented hirsutism, hypermastia and kyphoscoliosis. Roentgenographic studies showed no changes in the sella turcica, and bony thickenings were observed only at the cranial sutures. Medical and neurologic examinations revealed nothing significant. Intelligence was not reduced.

COMMENT

Neurofibromatosis belongs to a group of diseases which result from systemic developmental abnormalities of the ectoderm and mesoderm (anomalies of bone). Included in this group are infantile progressive

hypertrophic neuritis, tuberous sclerosis (Bourneville), dystrophia pigmentosa (Leschke), and congenital obesity with polydactyly and retinitis pigmentosa, known also as the Laurence-Moon-Biedl syndrome. Neurofibromatosis may also be associated with osteodystrophia deformans (Paget).

The first comprehensive description of the disease was given by von Recklinghausen in 1882. The disease may occur in two forms: (1) peripheral neurofibromatosis, including tumors in the skin and in the nerve trunks up to their exit from the dura, and (2) central neurofibromatosis, in which the tumors are situated intradurally in the nerves themselves or in the central nervous system. The disease was described as neurinomatosis by Verocay. It may be associated with diseases of bone and polyglandular disturbances of internal secretion.

The tumors may appear wherever there are nerves. In the skin, the changes appear as tumors or pigmentations, thickly spread over the trunk and the limbs. The tumors range from growths the size of the head of a pin to flabby, elephantiasis-like tumors. There are also pedunculated tumors, which disappear on pressure but fill again when pressure is released. The tumors are frequently covered with a bluish, telangiectatic skin, sometimes containing areas of hair or giant comedones. Similar tumors are sometimes observed on the mucosa. Pigmentary changes in the skin and the mucosa appear in the form of café au lait spots or as depigmented areas (leukoderma) and in the iris as brownish pigmented tumors. Neurofibromas are always related to the nerves; accordingly, they appear in a string of pearls form in the choroid and as a plexiform neuroma (so-called *Rankenneurom*) in the region of the eyes, ears, forehead and neck. They occur in the course of the vagus, acoustic and trigeminal nerves and along the sympathetic trunk, with special predilection for the cauda equina, in the medulla of the adrenal glands and in the spinal ganglions, but seldom in the liver, the kidney or the brain and its covering. Malformations, such as uterus bicornis or a missing kidney, may occur as well.

Pathologic Anatomy.—Macroscopically, neurofibromas are grayish red and of various sizes, and the nodular form may be rounded, spindle shaped, stalked or flabby. The tumor is related to a nerve, which may also penetrate the tumor. Microscopically, the growth consists of compact fibrous tissue with numerous oval or oblong nuclei and no sharp cell walls. The nuclei are arranged in palisade formation. In cross section the cells have an onion skin arrangement, the "peritubular" form, with an axis-cylinder in the center. The abundance of nuclei suggests sarcoma. Besides the cells, there is a reticulum-like tissue.

Skin.—Normally there are two types of nerve endings: The neurilemma, or the so-called sheath of Schwann, is changed into a capsule (Meissner corpuscles) in the skin. 2. Nonmedullated fibers penetrate

the basal layer of the epithelium and ramify about two special cell types: (*a*) the so-called Merkel-Ranvier corpuscles and (*b*) chromatophores. It has been proved that cutaneous nevi arise from neoplastic proliferation of these differentiated end organs, which have no longer any similarity to the structure of their original cells, but which are associated with medullated and nonmedullated cells. Dermal elements take part in some tumors, while in others there are epithelial elements or both. The nerve cell can become a chromatophore, thus forming the normal tissue chromatophore.

The Eye.—Pigment formation normally occurs only in embryonic life, but with the malignant degeneration of the tumor the embryonic cell activity returns and the cells once more become dopa positive. Pigment formation is, therefore, only the expression of a changed metabolic activity. Malignant neural tumors (neurogenic sarcoma) and sarcomas resemble each other strongly. Both have a fibrillar structure and numerous spindle cells, but the neurogenic tumors have not only spindle-shaped forms but oval and other types. All neurofibromas, plexineuromas, ganglioneuromatous nevi, melanomas and certain sarcomas (as mentioned before) are of neurogenic origin. Their cells arise from Schwann cells. Neurofibroma rarely occurs in the conjunctiva or in the sclera.

The choroid receives many vasomotor and sensory nerves from the ciliary nerve. They form ganglions; malignant tumors are observed in the outer layers of the choroid. One may conclude, therefore, that there is a connection between the chromatophores of the uveal tract and the nerve fibers which control these cells. Neurogenic tumors of the uveal tract are like Recklinghausen's neurofibroma, benign nevi and malignant tumors (sarcoma) in that they are not of mesodermal, but are of neuroectodermal, origin. Benign nevi may appear together with malignant nevi in the same eye, and they may mingle with each other in the iris as well as in the choroid. Theobald established the connection between malignant melanoma and the ciliary nerves. The alveolar structure and polymorphous cells of some sarcomas of the uveal tract prove their ectodermal origin. Sensory corpuscles resembling ganglioneuromas also occur. Thus, there are two kinds of tumor cells: (1) spindle-shaped Schwann cells and (2) pigment cells, not at all resembling the former, but presenting a strange metamorphosis of neural elements. Plexiform neuroma of the choroid is rare and occurs with buphthalmos. The latter, however, may have been caused by defective development of the angle of the anterior chamber. The papilla is excavated; the choroid and ciliary body may both be replaced with fibrous tissue rich in nuclei and of exuberant growth (arising in Schwann's sheath). The iris is seldom affected by neurofibromatosis. As shown in the accompanying figures, there occur areas of various sizes and small granules, part of

which are globular and part confluent. Some are mushroom-like, are attached to the iris and have a superficial capillary network. Their color varies from café au lait to coffee-brown. The nodules project from the surface, or remain on the level, of the iris. Except for the margin of the pupil, nearly all parts of the surface of the iris are invaded. The fibroid swellings have a strong tendency to sarcomatous degeneration.

The differential diagnosis is important when the fibromas occur singly, as in the case of warts (which do not have a smooth surface), lesions of cysticercosis (the consistency of which is hard), lipoma (which has no pigmentation) and the cutaneous metastases of carcinoma. The diagnosis of central neurofibroma is suggested in cases in which fibromas and pigmentations of the skin occur in the presence of symptoms of a brain tumor. Especially important is the differential diagnosis of

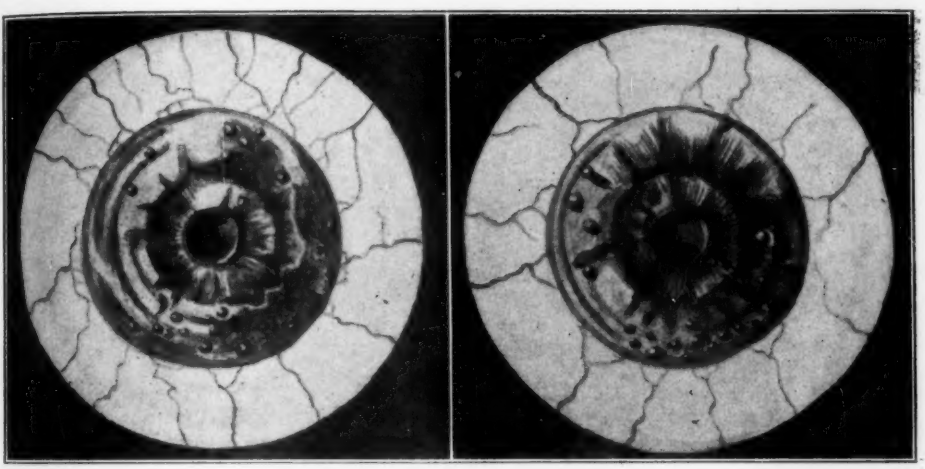

Fig. 1.—Irises in case 1.

cerebellopontile tumors (acoustic neurofibroma). As for general neurofibromatosis, therapeutic measures are without avail. In the case of a single lesion operation is indicated.

Course of Neurofibromatosis.—Neurofibromatosis may be congenital, or it may develop after birth. The tumors may grow quickly, slowly or interruptedly (pregnancy). During pregnancy, puberty and the menopause, and in connection with infectious disease and trauma tumors and pigmentations may occur and regress spontaneously. Central fibromatosis is dangerous, as the tumors tend to become malignant (Verocay).

Pathogenesis.—The origin of the tumor is an imperfectly developed group of cells which have migrated from the medullary tube and form Schwann's sheath, and the tumor is therefore called a neurinoma. The course of the process resembles that of tuberous sclerosis (Bourneville) in that there occasionally occurs a combination of abnormalities

(phakoma) or undeveloped embryonic tissue with formation of a tumor (blastoma). The neurofibromas at the papilla in cases of tuberous sclerosis, as in those of neurofibromatosis, seem to be due to sudden disturbance in the equilibrium of embryonic growth, perhaps with endocrine factors.

In the neuroectodermal tumor there appears mesodermal tissue, so that it is difficult to differentiate the primary and the secondary part of the tumor. Unlike tuberous sclerosis, neurofibromatosis is hereditary, as is the tendency to malignant degeneration. Women are attacked as well as men. The symptoms increase with successive generations.

Associated signs of the disease are kyphoscoliosis, osteomalacia and acromegaly; the last is not caused by a neurofibroma, or by the pressure

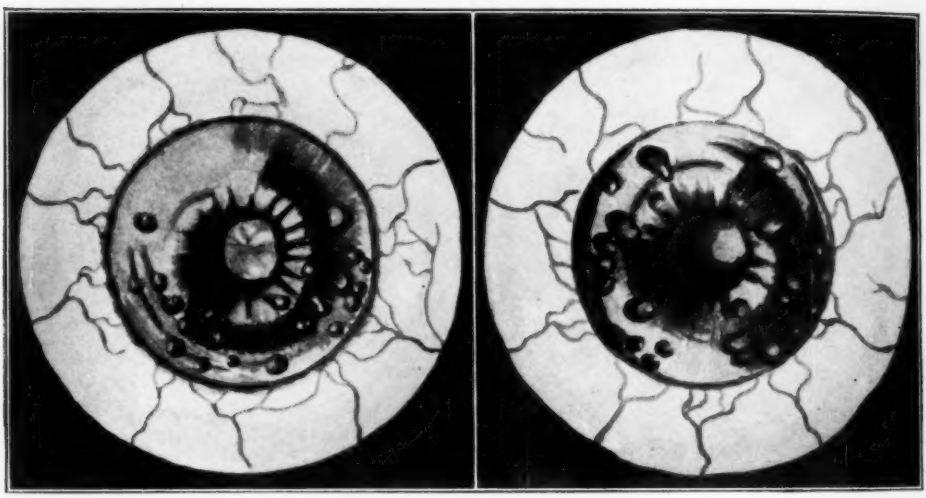

Fig. 2.—Irises in case 2.

of a neurofibroma, in the area of the hypophysis but is a part of the disease. Associated symptoms of the disease are dystrophia adiposogenitalis, diabetes insipidus, myxedema (polyglandular insufficiency), scanty menstruation, retardation of growth, hyperfunction of the glands of internal secretion and hypermastia. There also occur psychopathic changes, such as reduction of intelligence, morbid shyness or an inclination to violence, prostitution or epilepsy. Congenital anomalies, such as epispadias and exostoses, may be present.

SUMMARY

Two cases of neurofibromatosis (Recklinghausen's disease) involving the iris are described. In both cases the location in the iris was discovered in routine examination, and a general examination disclosed

the typical syndrome of the disease in other parts of the body, as well as involvement of the bones and the glands of internal secretion (cataract, hypermastia), signs which are usually associated with the disease. Location of the neurofibromatosis in the iris may not be as rare as is supposed if the possibility of the occurrence is kept in mind during examination with the slit lamp.

USE OF AIR INJECTIONS INTO TENON'S CAPSULE FOR LOCALIZATION OF ORBITAL FOREIGN BODIES

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THE EXACT localization of a single foreign body in relation to the globe is often extremely difficult; the presence of multiple foreign bodies complicates the problem proportionately. The military oculist is likely to encounter literally dozens of metallic or other fragments embedded in the tissues of the face, lids, globe, orbit, forehead, temple or nose. Most of these bodies may be ruled out as extraocular because of their remote position, but there often remain several which lie within the orbit, and possibly within the eye. To attempt to localize these fragments with the usual two plane exposures would require several tedious plottings. A still greater difficulty would be the virtual impossibility of distinguishing in the lateral projection between fragments which are intraocular and fragments which lie in the adjacent tissues or in the opposite orbit, temple, lids or side of the nose. Aside from these considerations, the x-ray equipment requisite for precise localization is frequently not available when needed.

The injection of air into Tenon's capsule [1] may be of considerable diagnostic value. The air outlines the contour of the globe, and this delineation provides a basis for judging the relative position of the suspected foreign body. If the foreign body is extraocular, it will be separated from the globe by the intervening air pocket. I have used this method in more than 20 cases and have found it exceedingly helpful.

A 10 cc. syringe armed with a straight 26 gage hypodermic needle is the most satisfactory means of injecting the air. A curved cannula must, of necessity, be of wider bore, and the heavier needle is much more difficult to insert into Tenon's space without inflicting undue trauma to the tissues and provoking hemorrhage into the conjunctiva. The upper outer quadrant is perhaps the most accessible locus for retrobulbar injection, but the penetration may be easily effected in any one of the four quadrants.

If the position of the foreign body or bodies is known roughly, the injection may be made in that area. In cases in which the presence of adhesions about the globe is suspected, it may be advantageous to inject air into two quadrants.

1. Spackman, E. W.: Am. J. Ophth. **18**:204-232, 1937. Staunig, K., and Herrenschwared, F.: Fortschr. a. d. Geb. d. Röntgenstrahlen **36**:372-374, 1927. Gasteiger, H., and Grauer, S.: ibid. **40**:272-278, 1929. Hughes, W. L., and Cole J. G.: Technical Uses of Air in Ophthalmology, Arch. Ophth. **35**:525-540 (May) 1946.

The injections should be made with proper regard for asepsis. The eyeball is rotated in such a direction as to expose most adequately the intended site. The conjunctiva and Tenon's capsule are grasped with a toothed forceps, and Tenon's space is entered, with the needle following the curve of the globe. The point of the needle is pushed to a position near the posterior pole. There is no danger of perforating the eye if the bevel of the needle faces the globe. The plunger of the syringe should be retracted slightly to permit warning against accidental entrance into a vein. The air is injected slowly. Ultimate leakage into the conjunctival interstices is inevitable, but this does not interfere with the desired results. However, if the conjunctiva balloons immediately, the needle is not in Tenon's space. In this event, the needle must be shifted to a deeper and more posterior position. The amount of air required is determined by the degree of exophthalmos induced, the resistance to the plunger and the extent of the conjunctival emphysema. Usually 6 to 10 cc. of air is adequate. The eyeball will be seen to proptose slowly during the injection. A good injection should cause a proptosis of 2 to 3 mm., and an increase in intraocular pressure of 8 to 10 mg. of mercury. The greater the volume of air, the more conspicuous will be the periocular shadow and the greater will be the displacement of any paraocular foreign body. The air is absorbed in five to seven days. There is little discomfort to the patient, and no untoward sequelae have been encountered in my experience. A patch should be worn over the eye for one or two days after the patient leaves the x-ray room.

The best roentgenograms are obtained when the patient is in the following position: The forehead, nose and malar bone rest on the cassette. The horizontal plane of the skull is perpendicular to the table, and the sagittal plane makes an angle of 52 degrees with the table. The tube is tilted toward the feet until the central ray makes an angle of 20 degrees with the horizontal plane of the skull. The beam is centered over the orbit nearest the film. Stereoscopic plates are made.

The cassettes must be scrupulously clean; if not, they will yield artefacts which may be indistinguishable from shadows of the true foreign bodies. If flawless cassettes are not at hand, cardboard film covers may be employed but one loses thereby the advantage of the intensifying screen which is built into the cassette. Higher roentgen energy is required without the intensifying screen; the amount approximates the epilating dose, and one must be careful not to overexpose the patient.

Bone-free exposures of the anterior ocular segment may be made at this time on dental film. The exophthalmic state of the eye will give opportunity for roentgenologic examination of more of the anterior segment than is usually projected in ordinary circumstances. It might be justifiable to inject air into Tenon's space for the sole purpose of bringing the cornea forward when bone-free films are required.

The clinical findings must always be correlated with the roentgenographic findings in interpretation of the plates. If the shadow of the foreign body falls external to the outlines of the globe, the foreign body must be outside the eye; such negative findings are always conclusive. Positive findings are less conclusive. The shadow of the foreign body may be superimposed on the shadow of the globe; yet the foreign body itself may lie outside the eye. The foreign body must lie outside the nearest tangential rays in order to register external to the outline of

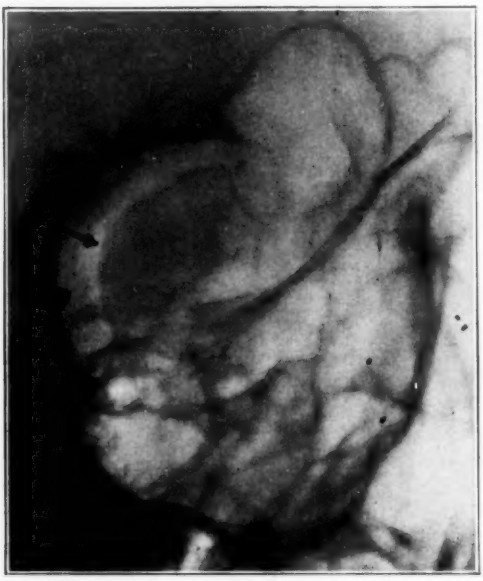

Fig. 1 (case 1).—Intraocular hemorrhage; traumatic chorioretinitis. Plain roentgenogram disclosed several foreign bodies in the region of the globe; more exact localization was not obtainable. Stereoscopic views taken after injection of air revealed four foreign bodies in the orbit, all outside the outline of the globe. In this figure, and in the accompanying figures, arrows indicate the outline of the globe.

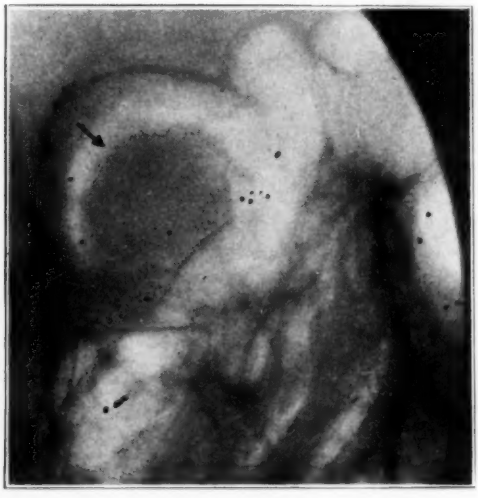

Fig. 2 (case 2).—Hemorrhage in the vitreous; traumatic chorioretinitis. After injection of air, eight foreign bodies were visualized within the orbital limits. Only two of them were within the outline of the globe; stereoscopic views revealed that one of these was outside the globe. The other was noted to be inside the eye; actually, it corresponded to a foreign body embedded deep in the cornea.

the globe. It may theoretically be necessary to make exposures from many angles in order to prove definitely that the foreign body is inside the eye; actually, however, this may be avoided by the use of stereoscopic films. In most instances the depth of the foreign body may be gaged with fair accuracy with the stereoscope. The films should be

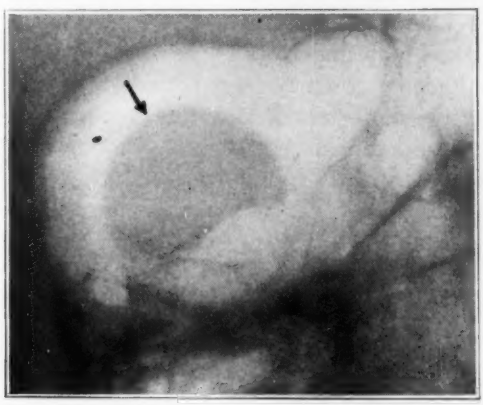

Fig. 3 (case 3).—Small patch of chorioretinitis in an eye exposed to an explosion. There was no evidence of perforation, but plain roentgenograms disclosed a small fragment in the orbit. The presence of a foreign body within the eye was suspected. Roentgenograms taken after injection of air revealed the foreign body to be well outside the air pocket. In this case there had been double perforation, the anterior perforation having become invisible after healing.

Fig. 4 (case 4).—Perforating injury by a fragment from a grenade. Roentgenograms taken at another station with a localizing contact glass revealed a foreign body definitely outside the eye. Double perforation was suspected. Stereoscopic views taken after the injection of air localized the foreign body within the globe, the diagnosis being verified by examination of the globe after enucleation.

drawn close to the observer's eyes in order to obtain the optimum size of the images. Routine stereoscopic roentgenograms have been found expedient and practical.

Injection of air is contraindicated in the presence of a large, recent perforation or in cases in which immediate operation is contemplated. In such cases there is danger of extrusion of some of the ocular contents because of the increased external pressure. Scheie and Hodes [2] recommended the use of oxygen instead of air and found that most of the gas was absorbed within eight hours.

The 4 cases illustrated by the roentgenograms are representative of the clinical conditions under which the use of injection of air and stereoscopic roentgenograms may be expected to be of assistance. The illustrations are positive prints, and the foreign bodies have been retouched for accentuation in reproduction. Arrows indicate the outline of the globe.

6 West Seventy-Seventh Street.

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2. Scheie, H., and Hodes, P. J.: Injection of Oxygen into Tenon's Capsule, Arch. Ophth. **35**:13-14 (Jan.) 1946.

USE OF ABSORBABLE CORNEOSCLERAL SUTURES IN CATARACT SURGERY

Report of Seventy-Six Cases

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REMOVAL of sutures after cataract extraction has always presented a difficult problem. In removing the sutures, not only does one subject the eye to the hazard of rupturing the wound; one subjects the patient to an ordeal which he seems to dread almost as much as the original operation.

Anyone who uses corneoscleral sutures has been fortunate indeed if while removing these sutures he has never had the experience of rupturing the wound sufficiently to produce a hemorrhage into the anterior chamber. A number of good ophthalmic surgeons condemn altogether the use of corneoscleral sutures because of the hazards which they present on removal.

It is not surprising that recently several physicians have made an attempt to solve this problem by the use of absorbable sutures. Davis [1] reported the use of absorbable corneoscleral sutures in 70 cases of cataract extraction. Hughes, Guy and Romaine [2] reported a series of experiments on the relative merits of various absorbable sutures in a series of rabbit eyes. Because of the encouraging results reported by these authors, I have, during the past two and a half years, used absorbable sutures in 76 cases. Since no further report of the use of such sutures has recently appeared, I feel that the report of these cases may be of interest.

Like the authors cited, I did not find any noticeable difference in the amount of tissue reaction to these sutures and to ordinary silk sutures.

In addition to the recognized advantage that the removal of sutures is eliminated, three other advantages appeared:

1. The patient does not complain of the feeling of a foreign body in the eye. With the use of silk sutures, this sensation of a foreign body in the eye grows constantly worse as long as the sutures are in place. If the patient is uncooperative and sensitive to any manipulation, it may be necessary to allow the silk sutures to remain as long as two weeks before they can be removed without danger of injury to the eye. It is

1. Davis, F. A.: Catgut sutures in Operation for Cataracts, Arch. Ophth. **31**:321-323 (April) 1944.

2. Hughes, W. L.; Guy, L. P., and Romaine, H. H.: Absorbable Sutures in Cataract Surgery, Arch. Ophth. **32**:362-367 (Nov.) 1944.

most unpleasant to listen to patients constantly complain of the presence of a foreign body during the entire time that the stitches remain; and it is even more unpleasant and disturbing to watch them blink and squeeze the eyes in an attempt to rid themselves of the foreign body.

2. The only postoperative hemorrhage in the present series was one into the anterior chamber; no postoperative prolapse occurred after the first twenty-four hours. The series is too small to permit conclusions, but I believe that the lessened feeling of a foreign body and the resulting lessened squeezing and blinking of the eye are responsible for these improved results.

3. For the first three days, the discharge from these eyes is as great as, if not greater than, the discharge from eyes in which silk sutures were used. After the third day, however, the discharge rapidly disappears. When silk sutures are used, the discharge continues, and, in fact, grows worse as long as the sutures are allowed to remain.

The operation used in this series is an adaptation of the technics of several other surgeons. The Liégard suture (more commonly, but perhaps improperly, called "Stallard suture") is used with a Van Lint flap. This procedure is a variation of Gifford's method, as illustrated by Bellows.[3] Unlike Gifford's regular suture, the ends of my suture are carried through the conjunctival flap before tying, so that the knot lies on the conjunctiva instead of directly on the corneal incision beneath the conjunctiva. This variation, too, is an adaptation of Gifford's method for the side extraction of a cataract, also illustrated by Bellows.[4] A round pupil is employed with a marginal iridectomy at 11 and 1 o'clock. Physostigmine is used when the operation is finished. No mydriatic is used prior to operation.

A point of interest is the color of the suture. It appears white, and as it absorbs one has the impression that the white suture remnant is an early infection of the corneal margin. If one does not recognize this, one will suffer unnecessary anxiety when looking at the eye on the second or third day.

Hughes and associates [2] used a variety of sutures, both chromic and plain. In the present series plain 0000 atraumatic surgical gut U. S. P. was used exclusively. From my limited experience, I am inclined to disagree with Davis and others who advocate 00000 or 000000 surgical sutures. I feel that a 0000 surgical gut suture is none too large, and it does not absorb as rapidly as the smaller sutures. Davis used silk for his conjunctival sutures. I used 0000 surgical gut for these sutures as well. They hold firmly and do not release the conjunctival flap before the fifth day.

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3. Bellows, J. G.: Cataract and Anomalies of the Lens, St. Louis, C. V. Mosby Company, 1944, p. 549.

4. Bellows,[3] p. 556, fig. 206; Am. J. Ophth. **26**:468, 1943.

"I disagree with the statement made by Ellett.[5] "Those who advocate catgut cannot realize the greater ease with which silk is handled, and the absorbability of the catgut is offset by its size." Instead of surgical gut being hard to handle, I find that it knots up less than silk. Unlike silk, it slips readily through the conjunctival flap and does not wrap itself into the conjunctival tissue, catching when one tries to pull it through, as silk often does. The thread will not split, as silk does. When dipped in water, it is perfectly pliable. Its larger size surely is not a condemnation, for it is more easily grasped with tissue forceps.

5. Ellett, E. C.: Use of the Suture in Extraction of Cataract, Arch. Ophth. **17**:523-529 (March) 1937.

SOLUTIONS USED WITH CONTACT LENSES

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A RESEARCH program was conducted throughout the year 1945 to obtain more information concerning the causes and prevention of clouding of the corneal epithelium by solutions used with contact lenses.

To eliminate varying personal equations, I used my own eyes exclusively and employed the same pair of contact lenses in all experiments.

PRESENT INVESTIGATION

Problem 1: Effect of Carbon Dioxide in Contact Solutions Used in Lenses.—It has been suggested that the carbon dioxide which passes through the cornea from the anterior chamber outward at the

TABLE 1.—*Effect of Carbon Dioxide in Solutions Used with Contact Lenses*

Solution	*p*H	Osmotic Pressure	Time of Corneal Clouding
Sodium chloride, 1.4%	6.8	1.4	1 hr. 45 min.
Sodium chloride + carbon dioxide	4.6	1.4	1 hr. 45 min.
Borate buffer solution	8.8	1.4 (NaCl)	2 hr.
Buffer solution + carbon dioxide	6.5	1.4 (NaCl)	2 hr.
Sodium bicarbonate	8.4	1.44 (NaCl)	1 hr. 50 min.
Sodium bicarbonate + carbon dioxide	7.2	1.44 (NaCl)	1 hr. 50 min.

recorded rate of 0.05 cc. per hour accumulates in the solution used with the contact lens and is responsible for, or is a contributing factor in, the clouding of the corneal epithelium.

In order to evaluate the truth of this contention, a series of solutions ordinarily used with contact lenses were saturated with carbon dioxide before they were placed on the eye. Each solution was prepared in a glass seltzer water bottle of the type sold for home preparation of carbonated water. A tank of pure carbon dioxide with controlling valves and gages was used to supersaturate each solution under a pressure of 35 pounds (15.9 Kg.) with vigorous agitation. The solutions were kept under pressure for twelve hours or more before use and were then ejected into a 50 cc. beaker just before they were to be worn. Each solution was allowed to stand long enough for any free carbon dioxide to escape from the solution, in order to prevent bubbles of carbon dioxide from forming under the contact lens after it had been placed on

the eye. The p_H of each solution was taken before and after the saturation with carbon dioxide.

A 1.4 per cent solution of sodium chloride was first used. This had an initial p_H of 6.8 and a p_H of 4.6 after saturation with carbon dioxide. When placed on the eye, the saturated solution was extremely painful for about seven minutes, and considerable conjunctival injection took place. After the stinging subsided, the lenses were wearable but not so comfortable as with pure 1.4 per cent sodium chloride. Clouding of the corneal epithelium took place in one hour and forty-five minutes. This is the exact time that I can wear a 1.4 per cent solution of sodium chloride without added carbon dioxide. The severe initial stinging could be due to the acidity of the solution or to free carbon dioxide.

The second solution used was a sodium borate–boric acid buffer, with an initial p_H of 8.8 and an osmotic pressure of 1.4 (sodium chloride). After saturation with carbon dioxide, the solution had a p_H of 6.5. As with the solution of sodium chloride, there was an almost unbearable stinging for about ten minutes, with immediate injection of the conjunctiva. The injection subsided in about twenty-five minutes. Clouding of the epithelium took place in about two hours, which is the exact time the same solution without the carbon dioxide can be worn.

The third solution used was a 2 per cent solution of sodium bicarbonate ($NaHCO_3$), with an initial p_H of 8.4 and an osmotic pressure of 1.44 (sodium chloride). After saturation with carbon dioxide, the p_H was measured as 7.2. As with the two previous solutions, there were an almost unbearably severe stinging and a conjunctival injection as soon as the lens was put on. In fact, the stinging was so bad that only the left lens was used in each of these experiments. Beads of perspiration were formed on the forehead, and I paced the floor. The stinging subsided in about six minutes and the injection in about twenty minutes. The lenses were worn for about one hour and fifty minutes before corneal clouding took place. This is the time that I can wear a 2 per cent solution of sodium bicarbonate without the added carbon dioxide.

With this last solution the p_H is on the alkaline side, which would indicate that the severe stinging is due entirely to the free carbon dioxide.

From these experiments, one can conclude that a solution saturated with carbon dioxide can be worn as long as the same solution without the carbon dioxide before corneal clouding takes place. Therefore, the presence of carbon dioxide in the solution does not hasten the clouding of the corneal epithelium. Considering that the addition of other substances, such as gelatin, to solutions for use with contact lenses will cause clouding in three to five minutes, it is not probable that carbon dioxide in solutions for use with contact lenses is the cause of clouding

of the corneal epithelium. It is possible that the accumulation of carbon dioxide and lactic acid in the corneal tissues contributes to the clouding.

As the results of this experiment were unexpected, and contrary to the accepted theory concerning edema, further substantiation of the foregoing conclusions will be the objective of further experimentation.

Problem 2: Effect of Added Oxygen to Solutions for Use with Contact Lenses.—It has been suggested that the isolation of the cornea from atmospheric oxygen is at least a contributing factor in clouding of the corneal epithelium when contact lenses are worn.

In order to obtain an idea of the part oxygen plays in this reaction, a series of solutions used with contact lenses were saturated with oxygen before use. The process of oxygenation was identical with that used to produce saturation with carbon dioxide except that oxygen was used instead. In this series, the p_H was not altered by the addition of oxygen.

A 1.4 per cent solution of sodium chloride was first used. When saturated with oxygen, it produced an immediate soothing and com-

TABLE 2.—*Effect of Added Oxygen to Solutions Used with Contact Lenses*

Solution	p_H	Osmotic Pressure	Time of Corneal Clouding
Sodium chloride, 1.4%.....	6.8	1.4	1 hr. 45 min.
Sodium chloride + oxygen.....	6.8	1.4	2 hr.
Sodium bicarbonate, 2%.....	8.4	1.44 (NaCl)	1 hr. 50 min.
Sodium bicarbonate + oxygen.....	8.4	1.44 (NaCl)	2 hr. 10 min.
Amino acid buffer.....	8.4	1.4 (NaCl)	2 hr. 25 min.
Buffer + oxygen	8.4	1.4 (NaCl)	2 hr. 35 min.

fortable sensation when in contact with the eye. The comfort lasted beyond the time clouding took place, two hours later. The wearing time before clouding was extended only fifteen minutes.

Next, a 2 per cent solution of sodium bicarbonate was used, with exactly the same reaction. The lenses were worn twenty minutes longer than without the added oxygen.

The third solution used was an amino acid–sodium borate buffer with an osmotic pressure of 1.4 per cent sodium chloride. The reaction of comfort was exactly the same in this instance and the wearing time ten minutes longer before clouding occurred.

If my eyes alone were considered, I should have to conclude that, while the presence of dissolved oxygen in contact lenses is soothing, it does not appreciably lengthen the time before clouding of the epithelium takes place. However, these oxygen-saturated solutions were used also with about 50 patients, who always reported greater comfort, with a reduction of the smarting and redness otherwise present and an added wearing time before clouding of up to an hour and a half. Added clearness of vision was also reported, due probably to reduction in formation of mucus with the reduced irritation.

It can be concluded, therefore, that solutions for use with contact lenses saturated with oxygen are comfortable to wear and in some cases lengthen the wearing time before corneal clouding takes place (table 2).

Problem 3: Effect of Osmotic Pressure on Corneal Clouding.—It has been stated that an osmotic flow between the corneal cell contents and the liquid used with contact lenses is the principal cause of clouding of the corneal epithelium. On the contrary, it has also been said that variation of osmotic pressure has little value in controlling this phenomenon. In order to evaluate the role osmotic pressure plays in the formation and prevention of clouding of the corneal epithelium, several experimental procedures were carried out.

I have contended that the osmotic pressure of the tears as they are excreted from the glands is not the same as the osmotic pressure of

TABLE 3.—*Results of Using Solutions of Sodium Bicarbonate of Successively Higher Osmotic Pressures with Contact Lenses*

Solution, %	Osmotic Pressure, (NaCl)	Time Solution Was Placed on Eye	Time Removed from Eye	N^d	Comments
2.0	1.44	10:20 a.m.	10:55 a.m.	1.3348	Comfortable; no clouding
2.3	1.61	10:55 a.m.	11:30 a.m.	1.335	Comfortable; no clouding
2.5	1.75	11:30 a.m.	12:15 p.m.	1.3352	Comfortable; no clouding
2.7	1.89	12:15 p.m.	1:00 p.m.	1.3354	Comfortable; no clouding
2.8	1.96	1:00 p.m.	1:30 p.m.	1.3357	Comfortable; no clouding
3.0	2.1	1:30 p.m.	2:10 p.m.	1.336	Slight sting on insertion; no clouding
3.3	2.31	2:10 p.m.	3:40 p.m.	1.3363	Comfortable; no clouding
3.6	2.52	3:40 p.m.	4:20 p.m.	1.3368	Sting 10 min.; no clouding
3.8	2.66	4:20 p.m.	5:05 p.m.	1.337	Slight sting 5 min.; slight clouding on removal
4.0	2.8	5:05 p.m.	5.45 p.m.	1.3374	Severe sting 10 min.; clouding gone in 3 min.; no clouding on removal

the tears covering the cornea; it is contended, rather, that the lacrimal fluids of two general osmotic pressures exist. First, the tears covering the lids and the unexposed bulbar conjunctiva are substantially the same as when excreted. The osmotic pressure of this fluid has repeatedly been reported as equal to 1.4 per cent sodium chloride. However, the tears over the cornea and, to a less extent, over the exposed conjunctiva are, of course, subject to rapid evaporation of their water content. The film of tears is thin and the area affected relatively large. It is reasonable to expect the osmotic pressure of the tears over the exposed cornea to be above 1.4 per cent sodium chloride. There are no data published concerning the osmotic pressure of the tears over the cornea or of the contents of the corneal epithelium. I knew from experience that if a solution with an osmotic pressure of 2 per cent sodium chloride was used with a contact lens the conjunctival irritation was severe enough to cause considerable conjunctival injection and smarting, even though the cornea did not seem to be affected.

The first experiment in this series was to determine how high an osmotic pressure the eye would tolerate if an attempt was made to produce tolerance, using solutions of successively higher osmotic pressures over a continuous period throughout the day. The amazing results are shown in table 3.

When the lenses were removed at 5:45 p.m., the eyes were comfortable and there was no injection. However, once the lenses were removed, a slight clouding with rainbows about exposed lights was immediately observable and lasted about thirty minutes.

After it had been proved that the eyes could tolerate an osmotic pressure of twice the accepted limit, it was then thought desirable to determine the minimum number of changes necessary for a given period and the greatest successive variation possible. One of these experiments, using sodium bicarbonate, illustrates the results obtained (table 4).

These periods of five successive hours of wearing time were obtained, using only three solutions, with osmotic pressures of 1.4, 1.96 and 2.66,

TABLE 4.—*Minimal Number of Changes During Continuous Wear of Solutions of Sodium Bicarbonate of Three Successively Higher Osmotic Pressures*

Osmotic Pressure	Time Worn Before Clouding	Comment
1.4	2 hr. 30 min.	Comfortable throughout wearing period
1.75	Changed at once	Comfortable
1.96	1 hr. 10 min.	Slightest sting on insertion; clouding cleared in 5 min.
2.31	Changed at once	Comfortable
2.66	1 hr. 50 min.	Slight sting for 5 min.; clouding cleared in 5 min.

respectively. It is to be noted that the clouding from the preceding wearing period was cleared in five minutes after each change of fluid to one with higher osmotic pressure.

As improved solutions were devised, as described later in this paper, my continuous wearing time for contact lenses was lengthened to seven or eight hours, with only two changes after the initial insertion, three solutions of successively higher osmotic pressures, 1.4, 2.03 and 2.6, being used. The slight clouding which occurred before each change cleared in three minutes.

The next logical experiment was determination of the possibility of using solutions of an osmotic pressure higher than had previously been thought possible without the progressive changes described in the preceding paragraph. Numerous experiments with solutions for use with contact lenses heretofore reported in the literature indicated that use of such solutions was impossible because the stinging, injection and discomfort experienced when solutions of this type were used with an osmotic pressure slightly above 1.4 per cent sodium chloride precluded their use by the average patient. My own eyes would not tolerate them.

Fortunately, during the latter part of 1945, experimental work was done with more complex solutions containing amino acids, potassium carbonate and methyl cellulose, which proved wearable when made in concentrations with osmotic pressures up to 2.375 per cent sodium chloride. Once slight clouding had taken place, the lenses could be refilled with fresh solution of the same kind and worn for an additional two to three hour period of cloud-free vision. It is interesting to note in table 5 that the initial wearing period lengthened as the osmotic pressure increased.

It may be concluded from the foregoing experiments that the eye will tolerate the solution used with contact lenses with an osmotic pressure as high as 2.8 per cent sodium chloride if the eye is conditioned in the proper manner. Further, the useful wearing time of contact lenses can be lengthened by the use of three successively stronger solutions of the more usual type. Finally, solutions using certain organic materials have increased efficiency with an osmotic pressure of about 2 per cent sodium chloride. Certainly, one can state positively that

TABLE 5.—*Wearing Times of Solutions of Amino Acids ("Parenamine"), Methyl Cellulose and Potassium Carbonate*

Osmotic Pressure	p_H	N^d	Wearing Time Before Clouding	Second Wearing Time Before Clouding *
1.4	8.5	1.3391	3 hr. 40 min.	2 hr.
1.74	8.0	1.3418	3 hr. 45 min.	2 hr.
2.037	8.6	1.342	4 hr. 50 min.	2 hr. 30 min.
2.375	8.0	1.3448	5 hr.	3 hr.

* Clouding cleared in 5 minutes after second insertion of lenses.

osmotic pressure is an important factor in a solution for use with contact lenses.

Problem 4: Value of Amino Acids in Solutions for Use with Contact Lenses.—Most of the solutions used with contact lenses have been composed of simple inorganic salts, mixtures of such salts or inorganic buffer solutions. It seemed likely to me that the absence of large, complex organic molecules, such as are present in the contents of living cells, might account, at least in part, for the unbalance which exists between the solutions and the contents of the epithelial cells of the cornea.

The amino acids, with their complex structure, protein origin and presence in living cells, combined with their nutritive value, seemed ideal for use as a starting point. I investigated the commercial sources of amino acids and their availability and cost at each source. Pure individual amino acids are expensive, and the amounts available are limited. Fortunately, this investigation revealed the existence of "parenamine" [1] N.N.R., a commercially available preparation of a mixture of

1. Manufactured by Frederick Stearns & Company Division, Detroit.

amino acids. "Parenamine" is a 15 per cent solution of amino acids, derived from the acid hydrolysate of casein. It contains all the amino acids known to be essential to man, plus other amino acids native to casein, which is a protein of high biologic value. "Parenamine" contains no protein polypeptides or other larger protein fragments which might be allergenic. Hydrolysis splits the protein molecule and destroys the biologic specificity of proteins. Amino acids themselves are not allergens.

Because of the acidity of "parenamine," any useful formulas had to contain alkaline salts to bring the mixture to a p_H of 8.0 to 9.0. It was natural to use the inorganic alkaline salts used for experimental work on inorganic solutions for use with contact lenses, which were present in quantity in the laboratory. Sodium bicarbonate, potassium bicarbonate and sodium phosphate were shown experimentally to be too weakly alkaline for use. Solutions of sodium borate with "parenamine" and of sodium carbonate with "parenamine" were produced with a variety of osmotic pressures. These solutions could be worn one to two hours longer than any of the inorganic solutions but were discarded because of the formation of precipitates on standing.

Attention was next turned to potassium carbonate, in combination with "parenamine," with the basic formula:

"Parenamine"	20.0 cc.
Distilled water	80.0 cc.
Potassium carbonate	1.4 Gm.
"Phemerol chloride"	2.0 cc.

The solution has a p_H of 8.2, a refractive index with sodium light (N^d) of 1.3387 and an osmotic pressure of 1.4 per cent sodium chloride. No precipitate was formed on standing. A variety of solutions with increasingly stronger osmotic pressures can be made by varying the percentages of "parenamine" and potassium carbonate. The p_H can be controlled between 8.0 and 8.8, which is desirable. In repeated tests, this series of solutions could be worn two to three hours longer than those composed solely of inorganic salts.

It must be concluded, therefore, that the addition of amino acids to solutions for use with contact lenses lengthens the time that I can wear them and that further investigation is warranted. These solutions are perfect culture mediums and are easily and quickly contaminated. No satisfactory sterilization for an opened bottle has been found.

Problem 5: Use of Methyl Cellulose in Solutions for Use with Contact Lenses.—The use of methyl cellulose in contact lenses was suggested verbally to me in 1944 by Mr. C. A. Oclassen, of the Westwood Chemical Company, and later an article appeared in the ARCHIVES suggesting its use not only in solutions to be worn with contact lenses,

but in other ophthalmic solutions.[2] Methyl cellulose has a twofold advantage. It has a wetting property with optical plastics and a lubricating and soothing effect, due to its viscosity.

Using a 4,000 centipoise pharmaceutic grade of methyl cellulose, a series of aqueous solutions were made to test its wetting property, with the following results:

% Solution	Results
0.001	Unsatisfactory
0.01	Fair
0.1	Good
0.25	Very good

Next, a series of solutions of methyl cellulose were made to determine the relative viscosity and practicability for use with solutions for contact lenses. The results were as follows:

Solutions, %	Results
2	Much too viscous
1	Too viscous
0.5	Viscous enough to stick to eyelashes
0.25	Satisfactory viscosity
0.1	Viscous enough for solutions in contact lenses

In view of the foregoing information, it was decided that a methyl cellulose content of 0.1 to 0.2 per cent should be used in the previously mentioned solution of "parenamine" for contact lenses. A typical formula is as follows:

"Parenamine"	30 cc.
0.2 per cent methyl cellulose solution	70 cc.
Potassium carbonate	2 Gm.
"Phemerol chloride" (1:1,000)	2 cc.

This solution has an osmotic pressure of 2.037, a p_H of 8.6 and a N^d of 1.342. A whole series of solutions with varying osmotic pressures can be prepared by varying the percentage of "parenamine" or the percentage of potassium carbonate or both. The methyl cellulose does not affect the osmotic pressure.

The wearing time before clouding takes place is longer than that with any other solutions I have used. The wearing time with this series varied according to the osmotic pressure, as indicated in table 5. Clearness of vision is also lengthened because of the continued wetting property of the added methyl cellulose. It neutralizes the effect of the deposited sebaceous material from the lid margins, which becomes troublesome in some cases.

It can be concluded from the evidence that the addition of methyl cellulose increased the wearing time, at least for me, with a "parenamine"–potassium carbonate solution.

2. Swan, K. C.: Use of Methyl Cellulose in Ophthalmology, Arch. Ophth. **33**:378-380 (May) 1944.

COMMENT

I do not offer the data in this paper as a solution of the problem of clouding of the cornea by solutions worn with contact lenses. It is offered only as an addition to the very small amount of experimental work which has been done on this problem. Much remains to be accomplished. Other organic components of living cells must be investigated. The minimum amounts of these substances which are effective and the prevention of contamination by fungi and bacteria will have to be determined.

Progress has been made, as table 6, listing my wearing times for these solutions, positively indicates.

TABLE 6.—*Wearing Times for Various Solutions in Contact Lenses*

Solution	Osmotic Pressure	Wearing Time Before Clouding
1.4% sodium chloride	1.4	1 hr. 45 min.
2.0% sodium bicarbonate	1.44	1 hr. 50 min.
1.4% sodium chloride and oxygen	1.4	2 hr.
Sodium borate-boric acid buffer	1.4	2 hr.
2.0% sodium bicarbonate and oxygen	1.44	2 hr. 10 min.
2.3% potassium bicarbonate	1.4	2 hr. 15 min.
"Parenamine" and sodium borate	1.4	2 hr. 30 min.
"Parenamine" and sodium carbonate	1.4	3 hr.
"Parenamine," sodium carbonate and methyl cellulose	1.4	3 hr. 15 min.
"Parenamine" and potassium carbonate	1.4	3 hr. 30 min.
"Parenamine," potassium carbonate and methyl cellulose	1.4	3 hr. 40 min.
"Parenamine," potassium carbonate and methyl cellulose	1.74	3 hr. 45 min.
"Parenamine," potassium carbonate and methyl cellulose	2.037	4 hr. 50 min.
"Parenamine," potassium carbonate and methyl cellulose	2.375	5 hr.

SUMMARY

The addition of carbon dioxide to solutions for use with contact lenses did not affect the time in which corneal clouding occurs.

The addition of oxygen to solutions for use with contact lenses did not materially increase the time before clouding takes place.

Solutions for use in contact lenses with osmotic pressures as high as 2.8 per cent sodium chloride can be worn if the pressure is progressively increased.

Osmotic pressure is important in solutions for use in contact lenses.

The addition of amino acids to solutions for use with contact lenses increases the time before clouding of the cornea occurs.

The addition of methyl cellulose to solutions for use with contact lenses increases the time before clouding of the cornea occurs.

49 East Fifty-First Street.

SPONTANEOUS LUXATION OF THE EYEBALL

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SPONTANEOUS luxation of the eyeball is so uncommon that few ophthalmologists have had the opportunity to study the condition closely, and the few who have had such an opportunity have often failed to determine a causative factor. Such a case was recently studied at this clinic.

REPORT OF A CASE

A Negro woman aged 42, who was extremely obese, was admitted to the hospital with both eyes taped tightly shut. She stated that four years ago a sharp pain had developed in the right eye; the eye became proptosed and finally popped out of the socket. The globe was replaced by a physician, who instituted a course of antisyphilitic therapy and prescribed a reducing diet. When on this regimen, she lost approximately 40 pounds (18.1 Kg.). She had no further trouble until December 1945, when she again began to gain weight. At this time she had frontal headaches, which were severest at night. In May 1946 she noticed that the right eye was again prominent and experienced spontaneous luxation of the globe one evening when she was not exerting herself. The eye was replaced by a physician, but luxations occurred several times during the ensuing week. She finally taped both eyes shut, leaving only a small fissure to see through. In June 1946 the left eye began to bulge, and she was fearful that spontaneous luxation of that eye would occur.

Her history revealed no illnesses except for malaria, contracted as a child and never treated, and syphilis, which had been partially treated six months prior to her admission to the clinic of this hospital. The urine was normal; the red cell count was 4,500,000 and the white cell count 10,000, with a normal distribution of cells; the hemoglobin was 14 Gm. per hundred cubic centimeters of blood, and the red blood cells and platelets appeared normal on smear. With exercise, the blood pressure varied from 104 systolic and 70 diastolic to 170 systolic and 90 diastolic. Roentgenograms of the chest and skull were normal, with the size and contour of the sella turcica within normal limits and the pineal gland not visible. The Kline diagnostic and exclusion tests gave negative reactions. The urea nitrogen of the blood measured 7.7 mg.; sugar, 82 mg.; total proteins, 7.6 Gm.; albumin, 3.8 Gm.; globulin, 3.8 Gm. (albumin-globulin ratio, 1.01); calcium, 10.6 mg.; inorganic

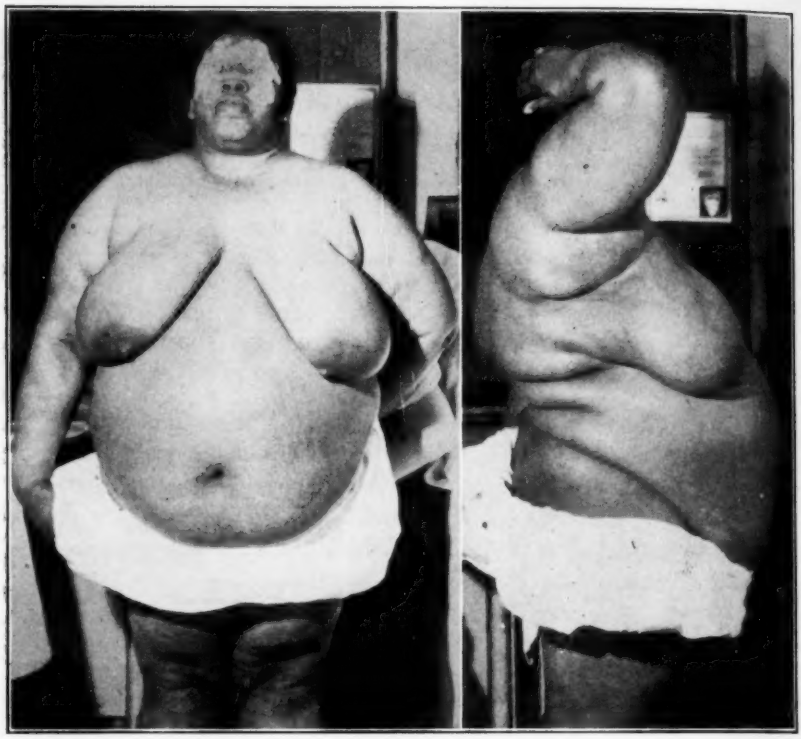

Fig. 1.—Photographs of the patient with obesity and spontaneous luxation of the eyeball. The eyes were taped shut on her admission.

Fig. 2.—Spontaneous luxation of the right eye

phosphate, 3.2 mg., and phosphatase, 6.7 units per hundred cubic centimeters. The cholesterol level decreased from 274 to 199 mg. per hundred cubic centimeters in seven days under treatment with thyroid. The basal metabolic rate varied from +16 to +29 per cent on successive days. A 1,000 calory diet was instituted, as her weight was 286 pounds (130.6 Kg.).

With 100 mg. of merperidine hydrochloride N.N.R. ("demerol hydrochloride") for sedation, the right eye was allowed to subluxate spontaneously for study. The globe protruded approximately 8 mm. beyond the external bony edge of the orbit. Funduscopic studies showed a normal condition, but visual acuity was not determined, owing to the patient's complaints of the pain. Moderate exophthalmos was noted after the eye was replaced, and the patient complained of tinnitus in the right ear.

COMMENT

Woods [1] stated that the basic cause of the disturbance in the lid closure-opening apparatus of patients with primary toxic diffuse goiter probably lies in the increased instability of the sympathetic nervous system, a sympathicotonia, together with certain reflex relaxations or contractions of the voluntary muscle, the exact nature of which is not clear, but which may or may not be related to pressure by the exophthalmic globe. Woods also stated that he did not consider the sympathicotonia or thyrotoxicosis related to the exophthalmos itself.

In his recent article on this condition, Means [2] stated that the ocular picture is a local manifestation of a fundamental, generalized disturbance of water and electrolyte metabolism. On the other hand, the diminished secretion of normal thyroxin may have an irritating effect on the anterior lobe of the pituitary gland and allow overproduction of a hypothetic hormone acting on the orbital contents. However, the exophthalmos of exophthalmic ophthalmoplegia is probably quite different from the exophthalmos of primary toxic diffuse goiter, being produced by organic changes in the orbit, actual hyperplasia of the orbital contents and hypertrophy of the extraocular muscles, whereas the exophthalmos of primary toxic goiter is produced by edema of the periorbital tissues.[3]

A review of the literature reveals 25 cases recorded with the following etiologic diagnoses: gumma, 2 cases; extreme exophthalmic goiter, probably exophthalmic ophthalmoplegia, 4 cases; cerebellar tumor, 1 case; insanity, 2 cases; exophthalmos without goiter, 3 cases; cause unknown, 8 cases; bifurcated superior oblique muscle with two inferior

1. Woods, A. C.: Ocular Changes of Primary Diffuse Toxic Goitre, Medicine **25**:113-153, 1946.

2. Means, J. H.: Diagnosis and Treatment of Hyperthyroidism, Canad. M. A. J. **43**:509-513, 1940.

3. Marine, D., in discussion on Aird, R. B.: Experimental Exophthalmos and Associated Myopathy Induced by Thyrotropic Extract, Arch. Ophth. **24**:1167-1178 (Dec.) 1940.

oblique muscles, 1 case, and spontaneous luxation due to shallow orbit in a deformed skull, including oxycephaly, 4 cases.[4]

Fowler [4a] classified cases of luxation of the eyeball under four types: (1) spontaneous luxation, arising from (*a*) oxycephaly, brachycephaly or related conditions due to premature synostosis, (*b*) exophthalmos, especially in Negroes and (*c*) exophthalmic goiter; (2) voluntary luxation, usually found in mentally subnormal Negroes, and probably due to a protractor action on the oblique muscles; (3) self-induced luxation, occurring in persons with mental disease, and (4) traumatic luxation, in which the globe is luxated but not avulsed.

By the type associated with exophthalmic goiter, we assume he means the syndrome referred to by many authors as exophthalmic ophthalmoplegia, and it is under this head that we prefer to place our case. It was decided to try resection of Müller's muscle, together with tarsorrhaphy and subsequent decompression of the orbit, if necessary. However, the patient signed her release and was discharged. It is hoped that we shall be able to follow this patient and gain more insight into the endocrine imbalance which produces such extreme ocular changes.

City Hospital.

4. (*a*) Fowler, J. G.: Spontaneous Luxation of the Eyeball: Report of Instance in Brachycephalic Patient, J. A. M. A. **116**:1206-1208 (March 22) 1941. (*b*) Ferrer, H.: Voluntary Propulsion of Both Eyeballs, Am. J. Ophth. **11**:883-886, 1929. (*c*) Mertins, P.: Subluxation of Eyeball, ibid. **5**:290-292, 1922. (*d*) Oertel, T. E.: ibid. **3**:814-816, 1920.

Clinical Notes

DIAGNOSTIC MUSCLE CHART FOR DETERMINATION OF TROPIAS, PHORIAS, DIPLOPIA AND MUSCLE ACTION

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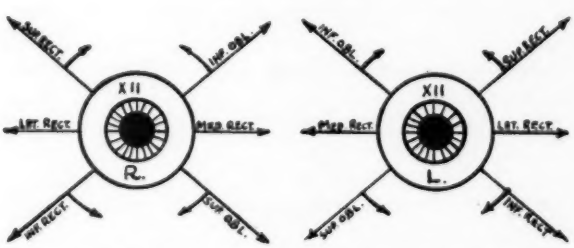
The accompanying chart is presented for use in the determination of tropias, phorias, diplopia and extraocular muscle action.

Up to Right R. eye higher— 1. overacting R.S.R. or 2. Weak L.I. oblique L. eye higher— 1 overacting L.I oblique or 2. weak R.S.R.	Straight Up R. eye higher— 1. overacting R.S.R. or 2. weak L.S.R. L. eye higher— 1. overacting L.S.R. or 2. weak R.S.R.	Up to Left L. eye higher— 1. overacting L.S.R. or 2. weak R.I. oblique R. eye higher— 1. overacting Rt. I. oblique or 2. weak L.S.R.
Directly Right Rt. does not move enough— weak R.E.R. L. moves too much—overacting L.I.R. L. does not move enough— weak L.I.R.	Straight Ahead Eye in-Con. squint Eye out-Div. squint Determine fixing eye	Directly Left L. does not move enough— weak L.E.R. R. moves too much—overacting R.I.R R. does not move enough— weak R.I.R.
Down and Right R. eye higher— 1. overacting L.S. oblique or 2. weak Rt. Inf. R. L. eye higher— 1. overacting R. Inf. R. or 2. weakness of L.S. oblique	Directly Downward Rt. eye higher— 1 weak R. Inf. Rect. or 2. overacting L. Inf. Rect. L. eye higher— 1. weak L. Inf. rectus or 2. overacting R. Inf. Rect.	Down and Left R. eye higher— 1. weak Rt. Sup. oblique or 2. overacting L. Inf. Rect. L. eye higher— 1. overacting Rt. Sup. oblique or 2. weak L. Inf. Rect.

Red glass in front of right eye

Pts. Right Red above—R.S.R. Green or white above —L.I.O.		Pts. Left Green or white above —L.S.R. Red higher—R.I.O.
Red to R.—R.E.R. Green or white to R. —L.I.R.		Green or white to L. —L.E.R. Red to L.—R.I.R.
Red lower—R. Inf. R. Green or white lower —L.S.O.		Green or white lower —L. Inf. R. Red lower—R.S.O.

Green glass or none in front of left eye



Diagnostic muscle chart for determination of anomalies of the extraocular muscles.

LOCAL USE OF "SULFAMYLON" (PARA-[AMINOETHYL]-BENZENE SULFONAMIDE HYDROCHLORIDE)

WILLIAM B. CLARK, M.D.
NEW ORLEANS

In the summer of 1946 my colleagues and I experienced considerable trouble with infections due to Bacillus pyocyaneus (Pseudomonas aeruginosa) as secondary contaminations with our surgical dressings. Although we tried many preparations and various procedures to control the contamination, none proved particularly successful. We finally had a case in which an infection with B. pyocyaneus invaded the inside of the eye after an operation for cataract and the eye was lost.

About this time we heard of "sulfamylon" [1] (para-[aminoethyl]-benzene sulfonamide hydrochloride), which was said to be suitable for ophthalmic use. The preparation was available in both 1 and 4 per cent solutions, buffered with citrate to a p_H of 6.5.

"Sulfamylon" is a sulfonamide compound with a wide range of antibacterial activity, but, unlike most of these drugs, it is not inhibited by paraaminobenzoic acid. It has, therefore, proved effective in the presence of pus and blood. For example, Beyer [2] treated a series of 60 patients with fresh wounds using the substance (known in Germany as "marfanil") as a prophylactic against infection, and 140 patients with infected wounds using it as an antiseptic. The results were almost uniformly successful, and Beyer concluded that the drug was a valuable aid in the treatment of wounds.

More recently, Howes and his associates [3] reported on a comparative study of "sulfamylon," calcium penicillin, parachlorophenol, tyrothricin and zephiran chloride with regard to efficacy, speed of action and toxicity. For local chemotherapy they found that "sulfamylon" was superior to the others, that it possessed the widest range of antibacterial activity and that it was relatively nontoxic.

On Oct. 1, 1946, we began using "sulfamylon" to irrigate the conjunctival sac and to saturate eye pads used for dressings. Since then we have used it in 84 successive surgical cases, and in no instance have we had a case of contamination with B. pyocyaneus. Moreover, there has been no drug reaction in the lids. A few of the patients, it is true,

From the Department of Ophthalmology, Tulane University of Louisiana School of Medicine.

1. The product was obtained through the courtesy of Winthrop Chemical Company, Inc., New York.

2. Beyer, W.: Zentralbl. f. Chir. **68**:1730, 1941; abstracted, War Med. **4**:121 (July) 1943.

3. Howes, E. L.: Surg., Gynec. & Obst. **83**:1, 1946. Local Chemotherapy of Wounds, editorial, J. A. M. A. **132**:333 (Oct. 12) 1946. Howes, E. L.: Ann. Surg. **124**:268, 1946.

have been exposed to the drug for only three or four dressings, but most of them are patients with cataract who have had dressings changed daily for seven or eight days. There were 5 cases of retinal detachment in which dressings were changed every other day. Each new dressing was applied moistened with 1 per cent "sulfamylon." This treatment was continued for a month after operation. In none of these cases did we have any of the reactions to the drug which we have experienced with other sulfonamide preparations, such as sulfathiazole.

It is also worthy of note that in no instance was there any pain, redness or irritation from irrigating the conjunctival sac with 1 per cent "sulfamylon." We have not used the 4 per cent solution for a sufficiently long period to determine whether it also is nonirritating. It appears at present that the 1 per cent solution is sufficient to control contaminations with B. pyocyaneus.

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News and Notes

EDITED BY DR. W. L. BENEDICT

GENERAL NEWS

Annual Postgraduate Course, Oregon Academy of Ophthalmology and Otolaryngology.—The Oregon Academy of Ophthalmology and Otolaryngology has announced its ninth annual spring postgraduate course in ophthalmology and otolaryngology, to be held in Portland, March 21 to 26, 1948. The program for this course is arranged by the Oregon Academy and the University of Oregon Medical School.

In ophthalmology, the guest speakers will be Dr. Albert D. Ruedemann, professor of ophthalmology at Wayne University College of Medicine, Detroit, and Dr. C. Allen Dickey, associate clinical professor of ophthalmology at the University of California Medical School, San Francisco.

In otolaryngology, the guest speakers will be Dr. French K. Hansel, associate professor of otolaryngology at Washington University School of Medicine, St. Louis, and Dr. James H. Maxwell, professor of otolaryngology at the University of Michigan Medical School, Ann Arbor.

The course consists of a series of lectures, clinical demonstrations and ward rounds. In order to be able to stress the practical demonstrations, the course will be limited to a total of 125. Any one interested should contact Dr. Harold M. U'Ren, secretary, 1735 North Wheeler Avenue, Portland 12, Oregon.

Rivista di oftalmologia Founded.—Florentine ophthalmology, more or less stagnant since the transfer of *Bollettino d'oculistica* to Rome, and as a result of the recent war, is undergoing a reawakening. Prof. Biagio Alajmo, director of the Institute of Clinical Ophthalmology of the University of Florence, has founded a new monthly journal in ophthalmology, *Rivista di oftalmologia,* which appeared in January 1946 and is published by L. Salpietra, Florence, Italy.

The editor of the Rivista is ably assisted by a group of well known Italian ophthalmologists—V. Accardi, A. Bencini, G. B. Bietti, F. Caramazza, D. Cattaneo, V. Cavara, A. Contino, Q. di Marzio, E. Federici, R. Gallenga, L. Guglianetti, G. Lo Cascio, L. Maggiore, V. Rossi, A. Santonastaso, S. Sgrosso, A. Rubino, M. Simonelli, and U. Azzolini. The *Rivista* includes in its pages original papers, reviews, therapeutic notes and abstracts from Italian and foreign journals.

Volume 1 contains excellent papers by many prominent Italian ophthalmologists. If this volume is a portend of the future, it is safe to say that *Rivista di oftalmologia* will make an enviable reputation in Italian ophthalmologic literature. American ophthalmologists greet this newcomer with best wishes for its continued success.

Eye Bank in New Orleans.—An affiliated "eye bank" has been organized in New Orleans which will have the cooperation of the

Louisiana State University School of Medicine and the Tulane University of Louisiana School of Medicine and Hospital.

The new eye bank is located in the Hutchinson Memorial Building, New Orleans, and Mrs. Orville Ewing is serving as executive director. The officers are Charles E. Fenner, president; Dr. William B. Clark, first vice president; George L. Hardin, second vice president; John F. Reilly, treasurer, and John W. Sims, secretary.

Dedication of Thigpen-Cater Eye Hospital.—The Thigpen-Cater Eye Hospital, commemorating Dr. Charles A. Thigpen and Dr. Job T. Cater, was dedicated on November 2 at Birmingham, Ala. Dr. Alston Callahan has been named director of the hospital.

International Organization Against Trachoma.—The International Organization Against Trachoma (I. O. A. T.) was founded officially by decision of the Thirteenth International Congress of Ophthalmology, at its meeting at Amsterdam in 1929. It provides a society at the meetings of which matters of scientific, therapeutic and international interest connected with trachoma may be discussed.

The last general assembly of delegates and members was held in London on April 21, 1939. The proceedings were reported in *Revue internationale du trachome* for July 1939 and in the *British Medical Journal.*

A meeting of the executive committee of the organization was held in Paris on May 17, 1947, at 66 Boulevard Saint-Michel. There were present: Dr. MacCallan, president; Dr. Wibaut, secretary general; Professor Nordenson, president of the International Congress of Ophthalmology; Dr. Ehlers, secretary general of the International Congress of Ophthalmology; Dr. Bailliart, president of the International Association for the Prevention of Blindness; Dr. Lavery, Eire, and Dr. Churchill, secretary adjoint of the International Association for the Prevention of Blindness. The accounts were scrutinized and passed as correct, and it was decided to hold the next general assembly of delegates and members and the scientific meeting in London in 1950.

The quarterly journal, *Revue internationale du trachome,* which is published in French and in English, is the official organ of the organization. Publication ceased during the war, but it is hoped that it will be resumed shortly. Articles by members of the organization may be sent to Dr. Jean Sédan, 94 rue Sylvabelle, Marseille, France, secretary general of *La Ligue contre le trachome,* editor of *Revue internationale du trachome.*

Membership in the International Organization Against Trachoma is by an annual subscription of 25s sterling; this may be paid to the account of the organization at the National Provincial Bank, 23 Wigmore Street, London, W. 1. Larger donations from ophthalmologic societies are invited for the purpose of meeting the general expenses of the organization.

If circumstances permit, *Revue internationale du trachome* will be posted to members as published.

Further information may be obtained from the president, A. F. MacCallan, Westminster Hospital Medical School, 17 Horseferry Road, London, S. W. 1, or from the secretary-general, F. Wibaut, P. C. Hooftstraat 145, Amsterdam, Netherlands.

UNIVERSITY NEWS

Refresher Course in Ophthalmology and Otolaryngology, University of Toronto.—The University of Toronto Faculty of Medicine announces a refresher course in the combined subjects of practical ophthalmology and otolaryngology from January 26 to 31, 1948. The course will be so arranged that the operative procedures and bedside conferences of the one specialty will be held in the morning and the didactic conferences or lectures in the afternoons. The reverse of this procedure in the other specialty will make it possible for each applicant to pick whatever subjects may be of interest to him. A full program will be published later and will also be available on application to the Medical Office, University of Toronto. The fee for the course is $50. The course will be given for a minimum of ten students and a maximum of twenty students.

Midwinter Seminar in Otolaryngology and Ophthalmology.—In 1948 the University of Florida Midwinter Seminar in Otolaryngology and Ophthalmology will be held at the Flamingo Hotel, Miami Beach, beginning on January 12 and continuing through January 17. The lectures in otolaryngology will be presented on January 12, 13 and 14 and those in ophthalmology on January 15, 16 and 17. The registration fee is $25.

The distinguished lecturers for the courses in otolaryngology include Dr. Lawrence R. Boies, Minneapolis; Dr. Louis H. Clerf, Philadelphia; Dr. Kenneth M. Day, Pittsburgh; Dr. Thomas C. Galloway, Chicago; Dr. James H. Maxwell, Ann Arbor, Mich.; Dr. Arthur W. Proetz, St. Louis, and Dr. Harry P. Schenck, Philadelphia. Among the outstanding ophthalmologists who will lecture are Dr. S. Judd Beach, Portland, Me; Dr. William L. Benedict, Rochester, Minn.; Dr. Daniel B. Kirby, New York; Dr. Peter C. Kronfeld, Chicago, and Dr. Dohrmann K. Pischel, San Francisco.

The Midwinter Seminar follows immediately the Pan-American Congress of Ophthalmology, which will be held in Habana, Cuba, Jan. 5 to 10, 1948. The dates chosen for the two meetings make possible a delightful opportunity to attend both and at the same time to enjoy a winter vacation amid unsurpassed resort attractions.

The University of Florida Midwinter Seminar in Otolaryngology and Ophthalmology.—The seminar in 1948 will be held at Miami Beach, Fla. The courses in ophthalmology will be given on January 15, 16 and 17. The lecturers will be Dr. S. Judd Beach, Portland, Me.; Dr. William L. Benedict, Rochester, Minn.; Dr. Daniel B. Kirby, New York; Dr. Peter C. Kronfeld, Chicago, and Dr. Dohrmann K. Pischel, San Francisco.

Application should be made to Dr. Walter T. Hotchkiss, Miami Beach, Fla.

SOCIETY NEWS

The Research Study Club of Los Angeles announces its seventeenth annual midwinter postgraduate clinical convention in ophthalmology and otolaryngology on January 19 to 30, 1948.

January 19 to January 24 will be given over to the section on ophthalmology. The principal speakers will be Dr. Francis Heed Adler and Dr. Harold Glendon Scheie, who will speak on the University of Pennsylvania's "school of thought" in ophthalmology; Dr. Phillips Thygeson, of San Jose, Calif., and Dr. Meyer Wiener, Coronado, Calif.

It is well to write for an early reservation to Mr. H. M. Nickerson, manager of the Elks Club, Parkview at Sixth Street, Los Angeles 5. In order to shorten the time of registration, it is suggested that the fee for the clinical courses, $75, be sent in advance to Pierre Violé, M.D., treasurer, 1930 Wilshire Boulevard, Los Angeles 5.

Conference of the National Society for the Prevention of Blindness, Inc.—The National Society for the Prevention of Blindness, Inc., announces that it will hold a three day conference April 5, 6 and 7, 1948, at the Hotel Radisson, Minneapolis. This conference will be of interest to persons who are directly or indirectly concerned with ocular health and safety. Details concerning the program may be obtained by writing directly to the Society, 1790 Broadway, New York 19.

PERSONAL NEWS

Dr. Culler Appointed Chairman of Department of Ophthalmology, Ohio State University School of Medicine.—Dr. Arthur M. Culler, a member since January 1946 of the staff of the department of ophthalmology of Ohio State University College of Medicine, Columbus, Ohio, has been elected chairman of the department, to succeed the late Dr. Albert D. Frost. Dr. Claude S. Perry has been acting chairman and will now continue as associate professor.

Dr. Culler received his degree of Doctor of Medicine at the University of Michigan Medical School in 1926; from 1928 to 1930 he served as instructor in ophthalmology at the University of Michigan and also held the John E. Weeks scholarship in ophthalmology during that period. During World War II he served in the South Pacific as a captain in the naval reserve.

Dr. Daniel B. Kirby Completes Lecture Tour in South America.—Dr. Daniel B. Kirby, of New York, has recently returned from a good will lecture and conference tour of South America, under the auspices of the Pan-American Association of Ophthalmology. He visited Rio de Janeiro and São Paulo, Brazil; Montevideo, Uruguay; Buenos Aires, Rosario and Cordoba, Argentina; Santiago, Chile, and Lima, Peru. In all countries, Dr. Kirby found the oculists receptive and cordial. Many plan to attend the third Pan-American Congress of Ophthalmology in Cuba, January 4-10, 1948, and to visit the United States directly before or after the congress.

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

PROBLEM OF THE INSERTION OF THE OBLIQUE MUSCLES AROUND THE MACULA. E. P. FORTIN, Arch. de oftal. de Buenos Aires **20:** 295 (July-Aug.) 1945.

Fortin suggests that the special anatomic and histologic architecture of the superior and inferior oblique muscles may have some bearing on a specialized function of the movements of the eyes, particularly in fixation. He stresses the fact that the insertion of these muscles in the sclera around the region of the macula is not well demonstrated by ordinary dissection. Microscopically it may be observed that many fibers of the muscle are inserted beyond the limits established by the dissecting knife.

He concludes that the oblique muscles encircle the macula and act on it. The article is illustrated with numerous photomicrographs.

H. F. CARRASQUILLO.

Aqueous Humor

CHOLESTEROL IN THE ANTERIOR CHAMBER. J. M. ICAZA Y DUBLAN, Bol. Hosp. oftal. de Nuestra Sra. de la Luz **3:** 143 (March-April) 1946.

A case of deposits of crystals of cholesterol in the anterior chamber of the right eye of a woman aged 40 is reported. The eye was blind, presumably due to a preexisting intraorbital inflammatory condition. One morning, after a cold bath, she had to cook on a wood range and received heat in her face. In the afternoon, after she had had an attack of severe pain in the eye, her relatives noticed a white spot. Examination revealed degeneration and atrophy of the iris, a posterior synechia and a pupillary membrane. The lower half of the anterior chamber contained a whitish mass, which was formed of small, glistening bodies. Similar bodies were also seen floating in the aqueous. With the slit lamp, numerous, typically colored crystals of cholesterol were observed forming the mass and floating in the aqueous, simulating a shower of diamonds.

According to the author, precipitation of the cholesterol crystals was brought about by the abrupt changes in temperature to which the patient's diseased eye was subjected.

H. F. CARRASQUILLO.

Conjunctiva

SULPHAPYRIDINE-RESISTANT KOCH-WEEKS [INFLUENZAL] CONJUNCTIVITIS. H. J. STERN, Brit. J. Ophth. **30:** 722 (Dec.) 1946.

During the past four years Stern has seen a considerable number of East African Negroes in military hospitals in the Middle East. The result of treatment of conjunctivitis due to Hemophilus influenzae (Koch-

Weeks bacillus) with sulfapyridine has been so disappointing in these patients that it had to be given up and the old-fashioned use of silver nitrate reinstated. The failure of sulfapyridine can be explained by the existence among these people of a sulfonamide-fast strain of H. influenzae. The possibility suggests itself that sulfapyridine-resistant strains of H. influenzae are harbored by carriers who themselves have only a mild chronic conjunctivitis but are in a position to infect others with it.

W. ZENTMAYER.

VERNAL CONJUNCTIVITIS. P. J. ALVARADO, Bol. d. Hosp. oftal. de Ntra. Sra. de la Luz **3**: 153 (May-June) 1946.

Alvarado believes that vernal conjunctivitis is a syndrome to be incorporated into the symptomatic picture of the actinic-hypovitaminotic keratoconjunctivitides. Present day knowledge of vitamins reveals that two important disturbances originate in hypovitaminosis: endocrine disorders and disorders of the liver and skin or allergy. From the action of ultraviolet radiation, it is evident that physical, climatic and geographic causes contribute to modify the ocular symptoms of the hypovitaminoses, although one cannot state conclusively what effect the endocrine disorders and allergies caused by hypovitaminoses may or may not have on the ocular disturbances.

M. E. ALVARO.

Congenital Anomalies

RUBELLA AND CONGENITAL ABNORMALITIES. Editorial, Brit. M. J. **2**: 778 (Nov. 23) 1946.

There seems to be little doubt of the association between rubella during pregnancy and the subsequent birth of a child with a congenital abnormality. Two questions still remain: How frequently does the association exist? In what proportion of all children thus defective is rubella the cause? The authors cite a number of articles, principally from the American press, and give the following answer: First, rubella during the early months of pregnancy has something less than a 10 per cent chance of damaging the fetus; and, second, of all such congenital abnormalities in children, 5 to 10 per cent may have their origin in damage by virus during intrauterine life. This suggests a complete reexamination of the etiology of congenital defects. It is, however, abundantly clear that rubella itself does not provide the entire explanation and that many other extrinsic factors should be included in the range of inquiry.

ARNOLD KNAPP.

Cornea and Sclera

POSTERIOR RING ABSCESS OF METASTATIC ORIGIN IN BEHCET'S DISEASE. A. FEIGENBAUM and W. KORNBLUETH, Brit. J. Ophth. **30**: 729 (Dec.) 1946.

A case of posterior ring abscess occurring in a man aged 28 with Behcet's disease, a chronic septic condition produced by Staphylococcus aureus in a constitutionally predisposed person, is reported. Prior to the

development of the corneal complication there had been present recurrent uveitis and retinitis.

W. ZENTMAYER.

SIMPLIFIED TREATMENT OF HERPETIC KERATITIS WITH ALCOHOL. S. LATORRE and G. CRESPI, Arch. Soc. oftal. hispano-am. **6**: 54 (Sept.) 1946.

The authors treated a series of 19 patients with herpetic keratitis with methyl alcohol. Of these patients, only 1 was resistant to the treatment, and he also proved resistant to the Gruter iodine treatment. The time required for cure averaged seven days, being in most cases only four or five days.

The technic used was as follows: After instillation of solutions of cocaine hydrochloride and fluorescein sodium, the application of alcohol was made with a small cotton applicator wet in 90 per cent alcohol, care being taken not to trespass beyond the areas of the lesions. The treatments were repeated every three days until no stain was obtained with the fluorescein. Usually one application was sufficient.

H. F. CARRASQUILLO.

Experimental Pathology

THE NEUROCAPILLARY TEST IN EXPERIMENTAL ANIRIDIA. F. VIDAL, J. L. MILBRÁN and J. G. BADARACCO, Arch. de oftal. de Buenos Aires **21**: 105 (April-June) 1946.

The action of carbaminoylcholine chloride on cats with experimental aniridia and partial iridectomy is studied. This drug first rapidly reduces the ophthalmotonus in both eyes. The reduction is followed by a slow increase in both eyes, the effect, however, being much less in eyes which have been operated on. These reduced values are interpreted as being due to the decrease in the dialytic vascular area.

A bibliography is appended. M. E. ALVARO.

MALE SEX ORGANS AND INTRAOCULAR PRESSURE. M. RADNOT, Ophthalmologica **107**: 282 (May-June) 1944.

Imre contended that some cases of glaucoma seem to be linked with androgens, whereas Velhagen asserted that there is no such relationship and that castration is of no influence on the intraocular pressure. Radnot believes he has shown that castration produces hypotony in rabbits, which lasts for a short time. Strangely, unilateral castration caused hypotony in the contralateral eye. Ligation of the duct, which leads to atrophy of the testicular tissue, caused contralateral hypotony immediately, or in some cases pronounced variations in pressure, followed by hypotony. Irradiation of the testis also produced contralateral hypotony. Castration changes the relation of the intraocular pressure to injections of anterior pituitary. (The experimental data are not at all convincing [Reviewer].)

F. H. ADLER.

General

PRESENT DAY PLASTIC CONTACT LENSES. E. AMORETTI, Ophth. ibero am. **7:** 287 (Oct.-Nov.-Dec.) 1946.

Amoretti considers three outstanding events in the development of plastic contact lenses: the obtaining of correct impressions of the human eye with the use of "negocoll" (an elastic hydrocolloid), by Dallos; the employing of plastic material instead of optical glass, by Obrig, and the substitution of "moldite" (a derivative of alginic acid) for "negocoll," by Obrig.

After commenting briefly on some of the papers presented at the first world conference on contact lenses, held in Chicago on Oct. 13, 1944, the author draws the following conclusions: 1. The use of contact lenses is the best method for the exact correction of most errors of refraction. 2. The widespread requirement for contact lenses can best be met at present by the molded plastic contact lens. 3. The successful use of contact lenses depends largely on obtaining perfect impressions. 4. The Anderson shell, used with the correct technic, provides the best impressions obtainable up to the present. 5. When one is considering the technic of fitting, a matter of fundamental importance should be borne in mind, namely, that excessively tight areas cause loose areas, which is frequently productive of a corneal touch. 6. Spherical and toric plastic contact lenses can be used with indisputable success in certain cases. 7. When these two types of lenses are used successfully, it is not only the structure of the eye but also the fact that the lenses are of plastic material that makes the necessary fitting possible. 8. In spite of the progress made, the important problem of appropriate ocular solutions has not yet been solved in an entirely satisfactory manner. 9. Obrig's secret method for correcting induced astigmatism should be divulged. 10. The ophthalmologist should fit contact lenses to patients with keratoconus.

H. F. CARRASQUILLO.

General Diseases

RETINAL HEMORRHAGES ASSOCIATED WITH SENILE PURPURA AND GLAUCOMA WITHOUT HYPERTENSION. E. REDSLOB and A. BRONNER, Ann. d'ocul. **179:** 63 (Feb.) 1946.

The authors point out that the retinal complications of purpura are extremely rare, especially if one excludes scurvy and the purpura secondary to infection. When hemorrhage does occur, it is usually orbital or subconjunctival ecchymosis. Bateman, in 1835, described five forms of purpura, of which one was senile purpura. He stated that this disease was limited to older women. Dusky, irregular spots are to be seen on the dorsal surface of the forearm. They last for ten to twelve days and disappear. After this early description, Unna, in 1896, and Pansini, in 1906, published reports on this condition. Pansini added to the original description the observation that the disease did not occur unless there was evidence of senile atrophy of the skin. The changes in the skin were the first symptom; the hemorrhages followed. The general physical condition of the patient was unaltered, and except for the condition of their skin they were in good health.

The authors wish to point out that this condition may not be limited to the skin and that hemorrhages may occur in other tissues.

The authors report in detail the case of a woman aged 74. When first seen, the patient had bilateral immature cataracts, as well as glaucomatous cupping of both nerve heads. The intraocular tension was subnormal. Cataract extraction was performed on the right eye and was complicated by a hemorrhage into the anterior chamber on the second postoperative day. Approximately two years later she was readmitted to the hospital, and it was on this admission that the purpura was noted. On this admission retinal hemorrhages were noted in the right eye. The intraocular tension was 15 mg. of mercury. The patient was thoroughly studied, and the only positive finding was increased capillary fragility in the tourniquet test. After treatment with ascorbic acid for several days, the intracapsular extraction of the left eye was performed. On the second postoperative day a severe anterior and posterior hemorrhage occurred. This gradually cleared and the nerve head showed the typical glaucomatous cupping as noted in the opposite eye.

The authors believe that their patient had senile purpura, as described by Bateman. In addition, she had retinal hemorrhages and glaucomatous cupping of the nerve heads without increased intraocular pressure. They ascribe the retinal hemorrhages to transient increases in arterial pressure. The capillaries are fragile, and the loss of elasticity decreases their ability to withstand changes in arterial pressure.

From previous studies on glaucoma, they conculde that the atrophy and cupping of the nerve head are on a vascular basis. In the case reported the intraocular tension was below normal. The atrophy and cupping of the nerve head are therefore probably due to the loss of elasticity, as noted in the other structures, as well as a diminished blood supply, which occurs with hypotension.

P. R. McDONALD.

DENTAL FOCAL INFECTION. J. R. SANCHEZ, Bol. d. Hosp. oftal. de Ntra. Sra. de la Luz **3**:179 (May-June) 1946.

Sanchez reaches the following conclusions: Knowledge of the existence of chronic dental foci and the lesions which they produce is of great importance both for the general practitioner and for the specialist. Immediate cure of the lesions is not always obtained after elimination of the foci, for often these foci are the result of a severe toxemia, which disappears slowly. When one is faced with an abnormal leukocytic formula, without specific cause, chronic foci should be thought of and roentgenograms taken of all the teeth. Greater collaboration of general practitioner, specialist and dentist is indispensable, as the modern surgeon dentist working in cooperation with the physician should play his part in preventing and curing serious diseases.

A bibliography is appended.

M. E. ALVARO.

Glaucoma

TREATMENT OF GLAUCOMA WITH NONPERFORATING CYCLODIATHERMY. L. WEEKERS and R. WEEKERS, Bull. Belgian. Soc. Ophth., 1945, no. 81, p. 50.

The anesthesia is accomplished by the instillation of cocaine and epinephrine, with the retrobulbar injection of 1 cc. of a 4 per cent solu-

tion of procaine hydrochloride (scurocaine). In order to make the operation entirely painless, 1 cc. of 40 per cent alcohol is injected five minutes after injection of the procaine. The electrode is a small cylinder, 0.75 mm. in diameter and 1 mm. in height. The lids are separated with the usual lid elevator. The electrode is applied directly to the eyeball without dissection of the conjunctiva, with enough pressure to maintain contact. The electrode is placed 7 mm. from the limbus. This is an important point. Eight applications are made, and they are placed at regular intervals between the tendons of the rectus muscles; each application is made for fifteen seconds. After the electrode has been withdrawn, there is a depression at the point of application. The bulbar conjunctiva is perforated, and the hole is somewhat larger than the diameter of the electrode. Around the margin there is a white halo from the coagulation and the ischemia of the surrounding conjunctiva. At the depth of the depression one sees the normal sclera. In order to avoid drying of the cornea, it is well to divide the operation into two or three stages and between each step to remove the speculum. The after-treatment is simple, and a dressing is not necessary. Atropine, 1 per cent, is instilled three times a day for three days during the phase of hypotony and as a preventive of posterior adhesions.

The authors conclude as follows:

1. Diathermization of the ciliary body has a definite hypotensive effect, which can be employed in the treatment of glaucoma. This effect is due principally to vasodilatation of the uveal vessels, which influences the circulation of the aqueous and aids in its absorption. There is in addition a certain amount of atrophy of the ciliary body, which will lead to continued reduction in the formation of aqueous humor and a decrease in the ocular tension.

2. The operative technic produces diathermization of the ciliary body without perforating the sclera. A point 7 mm. from the limbus is in the region of the ora serrata, which is a zone without danger to the ciliary body. Histologic examination has shown that the vascular condition produced by the diathermic action extends backward to the retina, while little action is exerted on the ciliary body, its processes and the iris. Every part of the ciliary body is involved, even when a very narrow electrode is applied to the posterior limit of the ciliary body. With application of the electrode nearer the limbus the hypotensive effect is greater, but is likely to cause iritis and cataract.

3. With chronic or subacute glaucoma it is possible to reduce the ocular tension to within the physiologic level at one sitting. This reduction is not generally as low as that obtained in the operation with entanglement of the iris. If necessary, in order to increase the hypotensive effect, the nonperforating cyclodiathermy may be repeated after a definite interval. If the choice is possible, the operation with entanglement of the iris is preferable to cyclodiathermy. The latter, however, is of great value when other operations have proved inadequate.

4. At the present time diathermy is not adaptable to treatment for acute glaucoma.

5. With secondary glaucoma the hypotensive effect of cyclodiathermy will be less constant than with chronic glaucoma. The result depends

on the condition which produces the hypertension. This procedure is especially useful when the hypertension occurs in a condition which is of itself capable of improvement, such as tuberculous uveitis. The nonperforating cyclodiathermy for such conditions permits the correction of the transitory hypertensive stage.

6. With painful absolute glaucoma nonperforating cyclodiathermy may replace the necessity of enucleation.

7. With infantile glaucoma the results of nonperforating cyclodiathermy are less favorable than those obtained with the operation with entanglement of the iris. Diathermy, nevertheless, is a useful treatment when the latter operation has shown itself to be inadequate.

8. Nonperforating cyclodiathermy, if it is correctly executed, has a remarkable anodyne action, much greater than the perforating cyclodiathermy of Vogt.

9. The technic may still be improved on. It is desirable to continue research on the means by which the tension of the glaucomatous eye may be reduced without injury to the eyeball. ARNOLD KNAPP.

PHYSIOLOGIC DRAINAGE OF THE INTRAOCULAR FLUIDS REESTABLISHED BY HEMICYCLODIALYSIS. A. TORRES ESTRADA, Bol. d. Hosp. oftal. de Nuestra Sra. de la Luz 3: 121 (March-April) 1946.

The author establishes the existence of two fundamental stages in glaucoma, the one functional and the other degenerative. The functional stage is determined by hyperemic phenomena in the external and internal membranes of the eye. The degenerative period is ushered in by the beginning formation of the glaucomatous excavation of the papilla.

Torres Estrada is a fervent advocate of hemicyclodialysis for glaucoma. The procedure is a classic cyclodialysis which is extended half around the limbus. He has replaced the fistulizing operations with this type of intervention. According to him, the failures of this operation reported by other surgeons are due to the advanced stage of the disease in the eye at the time of operation. In cases in which the glaucoma has progressed to a considerable extent he accompanies the hemicyclodialysis with iridectomy.

The generally accepted theory of the modus operandi of cyclodialysis is that it establishes drainage of the aqueous humor into the suprachoroidal space. Against the procedure it is claimed that the passage opened by the operation is closed promptly by cicatrization and the drainage is thus of short duration. Torres Estrada's idea, which he has proved recently by histopathologic examination of the eyes of cadavers in which the operation had been performed and which were not in an advanced stage of glaucoma, is that with this operation the intraocular fluids are drained into the canal of Schlemm, as normally occurs. The disinsertion of the fibers of the ciliary muscle from the inner wall of the canal of Schlemm, which is formed chiefly by these fibers, and the opening of the meshes of the pectinate ligament by the operation reestablish the physiologic drainage of the intraocular fluids. H. F. CARRASQUILLO.

Injuries

TRAUMATIC MYOPIA AND HYPERTONIA. ROGER WEEKERS, Ann. d'ocul. **178:** 236 (June) 1945.

The author presents the case of an 11 year old boy who was hit in the left eye. The patient was seen the day after the accident. There were hematoma of the lids, subconjunctival hemorrhage and edema of the retina with some fine hemorrhages. The anterior chamber of the injured eye was slightly shallower than that of the right eye. The lens was grossly normal, and examination with the slit lamp did not reveal any change. Vision in the left eye was improved to normal with a — 3.50 D. sphere. The intraocular tension was very low on palpation. The patient was placed under treatment with atropine. In approximately one month vision was normal with a + 1.00 D. sphere. The eye was injured again at this time. Vision and tension gradually returned to normal over a period of about six weeks.

The author does not believe that the myopia was caused by spasm of the accommodation, change in refractive index of the intraocular fluids or anterior displacement of the lens. He attributes the myopia to a relaxation of the zonule brought about by hyperemia and edema of the ciliary body and the hypertonia to an increased absorption of the aqueous.

P. R. MCDONALD.

REVIEW OF CONTRIBUTIONS OF WORLD WAR II TO OPHTHALMOLOGY. RICHARD J. HESSBERG, Ophthalmologica **112:** 292 (Oct.-Nov.) 1946.

The author reviews more than two hundred papers from the ophthalmic literature from 1939 to 1945 and gives the following summary 1. Most of the perforating ocular injuries resulted from mines and other explosives. 2. All injuries of the eye should be sent to the ophthalmologic departments as quickly as possible. At the first aid station only cleaning and dressing should be done. 3. The direct suture of corneal wounds is the method of choice. Widely gaping perforations need conjunctival flaps. 4. The multitude of foreign bodies and the majority of small nonmagnetic fragments make the posterior route the method of choice for the extraction of intraocular foreign bodies. 5. Early enucleation of a blind eye is preferable to evisceration, which should only be done in case of true panophthalmitis. 6. Blast causes severe damage to the eyes. It may mean complete loss. 7. In injuries to the orbit only careful examination of its contents and roentgenograms will show the extent of the injury. For proper treatment medical teamwork is important.

F. H. ADLER.

Neurology

SIGNIFICANCE OF CORNEAL AND PHARYNGEAL REFLEXES IN NEUROLOGY AND PSYCHIATRY. M. OSTOW and M. OSTOW, Arch. Neurol. & Psychiat. **55:** 320 (April) 1946.

In this paper, the distribution of variations in corneal and pharyngeal reflexes and their relations to other physical and mental signs are repre-

sented. The authors included in the study 141 patients: 58 young men in various stages of acute psychoses and 83 maladjusted persons with a mental state just within the limits of psychiatric normalcy. The results of their study indicate that any patient who exhibits absence of corneal reflexes in the presence of an active pharyngeal reflex should be strongly suspected of having organic disease of the brain.

S. R. IRVINE.

THE NERVE-FIBRE BUNDLE DEFECT. H. M. TRAQUAIR, Tr. Ophth. Soc. U. Kingdom **64:** 3, 1944.

This paper was presented as the presidential address before the annual congress of the ophthalmological Society of the United Kingdom in 1944. The important anatomic points concerned were briefly reviewed. The term "nerve fiber bundle" in connection with the field defects described refers to any small group of fibers which lie together as they enter the papilla, although there is no anatomic segregation into such groups in the retina. Traquair summarizes these field defects as follows:

The nerve fiber bundle defect is a common type of field change associated with lesions of the visual pathway between the retina and the chiasm. It would probably be more frequently found with conditions with which it seems to be uncommon if it were more carefully looked for. It shows that fibers which lie close together in the retina remain close together at least as far as the chiasm. Such defects are produced in connection with pressure injury and inflammation, and possibly with vascular obstruction. No satisfactory explanation of their production in cases of glaucoma has yet been suggested. The presence of this type of defect in association with several pathologic conditions suggests that there must be a common causal factor. This suggestion is supported by the observation that the typical field defects of chiasmal lesions also show common features with different causes. The common factor is probably anatomic and concerned with the finer arrangement of the nutritive vascular supply to the fibers. It may be surmised that this principle holds good throughout the visual pathway.

The relative absence of straight nerve fiber bundle defects in the temporal fields is noticeable at every level from the retina to the chiasm except in cases in which the position of the lesion is fortuitous, as in those of juxtapapillary choroiditis or injury. The fact that such defects are less noticeable by the patient does not satisfactorily account for this peculiarity. In cases of vascular obstruction, and also of retinal angiopathy, the vessels which surround the macular area are frequently affected; those on the nasal side are rarely involved. Is it possible that some condition of the vessels is the factor which links together all these conditions, including glaucoma and lesions of the optic nerve and chiasm? The absence of nerve fiber bundle defects with the toxic amblyopias supports the view that the field changes in some of these conditions at any rate, depend primarily on damage to the retinal cells rather than to the fibers.

W. ZENTMAYER.

OCULAR NEUROCIRCULATORY ASTHENIA: REPORT OF A CASE. A. GRAMMATICO, Arch. oftal de Buenos Aires **21:** 97 (April-June) 1946.

The author states that in many patients subjective symptoms are often improved after correction of refractive errors; others require in addition the removal of foci of infection. Even with this treatment some patients do not improve in spite of clinical attention and serologic tests. Many of these patients have ocular neurocirculatory asthenia, demonstrated by changes in the arteriovenous relation, narrowed visual fields, decreased ophthalmotonus, intolerance for the parasympathomimetic drugs and a hematic and somatic syndrome. Great improvement was obtained with instillations of a 5 per cent solution of sulfate of 1-phenyl-2-methylamine-propanol-1 (ephedrine sulfate), an acid diet and thyroid opotherapy. A control is kept by watching the visual fields, which show a surprising improvement. The ophthalmotonus remains unchanged.

A bibliography is appended.

M. E. ALVARO.

Ocular Muscles

HETEROPHORIA—DIAGNOSIS AND TREATMENT. EDWARD HARTMANN, Ann. d'ocul. **179:** 71 (Feb.) 1946.

The author was greatly impressed during his stay in the United States with the systematic way in which American ophthalmologists measured the ocular muscle balance. The purpose of this paper is to familiarize the French ophthalmologists with a simple routine to be followed and with how heterophoria should be treated.

The Maddox rod and screen and parallax tests are fully described, as well as the way in which the results should be tabulated. The author then describes the measurement of prism convergence and divergence. The results of the examination and the patients' symptoms are then evaluated. The routine use of prisms for the correction of heterophoria is deprecated. The author feels that some attempt at treatment—convergence exercises, use of loose prisms or orthoptic training—should be tried, especially in cases of the lateral phorias, before prisms are prescribed.

In cases of the hyperphorias exercises are of little benefit—here the prisms are usually prescribed to correct one half to two thirds of the vertical imbalance.

In selected cases surgical intervention may have to be considered.

P. R. MCDONALD.

GLAUCOMATOUS IRIDOPLEGIA AND THE MIOSIS OF THE ARGYLL ROBERTSON SYNDROME. F. VIDAL and M. BRODSKY, Arch. de oftal. de Buenos Aires **21:** 123 (April-June) 1946.

The authors believe that the local metabolic alterations of the smooth cells of the iris can produce distinct alterations in the pupillary diameter, according to the cells attacked—miosis in the Argyll Robertson syndrome and mydriasis in acute glaucoma. A bibliography is included.

M. E. ALVARO.

Orbit, Eyeball and Accessory Sinuses

AN UNUSUAL CASE OF INTRA-OCULAR HEMORRHAGE. D. W. McLEAN, Brit. J. Ophth. **30:** 758 (Dec.) 1946.

A woman aged 43 had had blurring of vision in the left eye since the previous evening. The pupil was half filled with a bead of red blood about 3 mm. in diameter. Dilation of the pupil showed a strand of pupillary membrane stretching roughly horizontally across the pupil. The hemorrhage proceeded from this strand, close to the temporal margin of the pupil, and extended forward in front of the margin. There was no history of trauma, but, as the patient had been playing with a boisterous child immediately before the onset, the occurrence of a minor injury seemed likely.

W. ZENTMAYER.

Refraction and Accommodation

FREQUENCY OF ERRORS OF REFRACTION. A. J. GONZALEZ, Arch. chilenos de oftal. **2:** 19 (Nov.-Dec.) 1945.

The national statistics show that hyperopia is the most common error of refraction noted among the school children of Chile. The average percentage is 52.27. The hereditary factor is believed to be of importance from an etiologic viewpoint. The frequency of hyperopia is due to the high percentage of degrees under 3 D. Myopia occurs in 29.46 per cent. It is interesting to study the hereditary, constitutional and hormone deficiency factors in the young myopic patients, for these seem to be of greater importance than the mechanical causes (such as reading small print and incorrect body position), although the latter are, of course, of relative value.

A bibliography is appended.

M. E. ALVARO.

Retina and Optic Nerve

A MACULAR LESION OF UNDETERMINED ORIGIN: REPORT OF FIVE CASES. PIERRE HALBRÓN and ALEXANDRE ROZAN, Ann. d'ocul. **179:** 131 (March) 1946.

The authors report 5 cases of an interesting macular lesion noted in returning prisoners of war. The cases were all observed in the latter part of 1945. In each case the lesion was limited to the macula; the periphery of the fundus and the retinal vessels were within normal limits. The lesion was characterized by disappearance of the foveal reflex and an increase in redness of the macular region. In 1 case the lesion appeared somewhat like a "hole in the macula," but no difference in level was noted between the fovea and the surrounding retina. In another case faint lines through the macula gave it a wrinkled appearance. Around the macula in an area about the size of the nerve head the retina was slate gray. There was no evidence of any elevation, and at no time were any hemorrhages, exudates or edema noted. Visual acuity was reduced to from 1/10 to 6/10 in all cases. The lesion was binocular in 4 of the 5 cases.

Two of the patients had suffered injuries from blasts, while 3 had undoubtedly been undernourished. The authors think that the lesion may be due to a deficiency of some factors essential to health. There was no obvious vitamin deficiency, but all the patients observed had been prisoners of war.

The treatment employed was mercury and acetylcholine and was followed by some improvement.

P. R. McDONALD.

CENTRAL SEROUS RETINOPATHY. H. ROCHA and B. GOMES, Brazil med. **59:** 21 (April) 1945.

The disease is briefly described. Six excellent case histories are given in detail, and the conclusion is reached that an allergic etiologic factor predominates, usually tuberculosis. The retinal lesion may be slightly decentralized, although this finding is rare. The prognosis is generally favorable, cases of secondary detachment being rare. Hypermetropia is one of the most common symptoms, disappearing with regression of the process. Treatment is directed toward the cause—tuberculin desensitization, removal of foci of infection, abstention from allergic substances and treatment of syphilis when present.

M. E. ALVARO.

Society Transactions

EDITED BY DR. W. L. BENEDICT

AMERICAN OPHTHALMOLOGICAL SOCIETY

Eugene M. Blake, M.D., *President*

Walter S. Atkinson, M.D., *Secretary-Treasurer*

Eighty-First Annual Meeting, Hot Springs, Va., Nov. 12-14, 1945

Early Ocular Manifestations in the Laurence-Moon-Biedl Syndrome. DR. DONALD J. LYLE, Cincinnati.

The Laurence-Moon-Biedl syndrome consists in obesity, hypogenitalism, mental retardation, polydactyly and retinal degeneration. The onset is in early life, and the disease may be detected before the school age. The subjective symptom is loss of central vision, not correctible with glasses. Three case reports were presented. Other conditions which resemble the Laurence-Moon-Biedl syndrome, and which must be differentiated from it, are heredomacular degeneration, Leber's optic atrophy (hereditary optic nerve atrophy), cerebromacular degeneration and retinitis pigmentosa.

DISCUSSION

DR. WALTER I. LILLIE, Philadelphia: Dr. Lyle's differential diagnosis of the Laurence-Moon-Biedl syndrome is excellent. The early stages of this syndrome often place the ophthalmologist in a peculiar position. At this time the fundi are normal, but the central visual acuity is reduced and is not improved by corrective lenses. There is a central scotoma in the field of vision of each eye. Young persons with this syndrome have increased weight, and the condition is suggestive of a pituitary disorder. Because the ophthalmologic examination reveals a prechiasmal syndrome which might be of pituitary origin, roentgenograms of the sella turcica are necessary for proper diagnosis. As far as I know, however, the roentgenogram in cases of this syndrome reveals no pathologic changes in the region of the sella turcica. When the syndrome is well developed, there are definite pallor of the disk associated wtih loss of central visual acuity and typical findings of retinitis pigmentosa. There is then no difficulty in differentiating the condition from the ordinary chiasmal syndrome. The ophthalmologist should be alert to the probability of bilateral chronic retrobulbar neuritis as the early stage of the Laurence-Moon-Biedl syndrome.

Dust-Borne Infection in Ophthalmic Operations. DR. M. HAYWARD POST JR., St. Louis.

Infections may take place in ophthalmic surgical procedures through any of the following sources: (1) contamination residual in the conjunctiva, the glands of the lids, the lacrimal apparatus and the skin;

(2) the hands and gloves of the surgeon, assistant and nurses; (3) droplet infection through the masks of the participants, and (4) dust-borne organisms. A series of experiments designed to study the dust-borne infections indicated that dust-borne organisms play a large part in the contamination of water bath, towels and instruments. The predominating organism in all growth-yielding cultures was the Bacillus subtilis.

Although air conditioning either by sterile lamps or by triethylene glycol vapor is effective in reducing the number of air-borne organisms, it is quite impractical in most hospitals. The following simple procedures are of value in combating infections from dust-borne organisms:

1. Covers should be kept on all solutions, towels, instruments, and the like, as much as possible.

2. An aqueous solution of benzol konium chloride ("zephiran chloride"), or similar detergent, is substituted for the water bath.

3. All instruments that are actually to enter the eyeball are dipped in a suitable sterilizing solution, or boiling water, for at least two and one-half seconds immediately before use.

4. Some method for air sterilization in the operating room is installed as soon as practicable.

5. All blankets and sheets are treated with a dust-laying oil (Harwood, F. C., and others: *Brit. M. J.* **1**: 615 [May 6] 1944).

6. The floor of the operating room is treated with some type of dust-allaying preparation.

DISCUSSION

DR. WILLIAM M. JAMES, St. Louis: Since Dr. Post has been interested for many years in sterilization of the sharp instruments used in ophthalmic surgery, it is fitting that he should call attention to the dust-borne infections and, at the same time, suggest methods of their control. The results of cultures of material taken by Dr. Post and his assistants from surgical instruments indicate that the instruments were being contaminated in the uncovered water bath. When they dipped the instruments either in boiling water or in benzol konium chloride, 1:3,000, the percentage of culture-yielding growths was reduced considerably. Dr. Post has told me that some rusting of the instruments has followed the use of benzol konium "zephiran" chloride in the water bath. The Alba Company states that this factor may be controlled by using a 0.5 per cent solution of sodium nitrite in the solution of benzol konium chloride.

DR. WILLIAM H. CRISP, Denver: Everything which one can do to improve the sterilization of instruments is not only justified but demanded. I wonder, however, whether one does not underestimate the capacity of nature. I have never seen anything to lead me to believe that I picked up an infection from the air of a well conducted operating room. Throughout most of my professional career, any sterilization of instruments has been done by simple immersion, not in actively boiling water but in water which has been boiling before I used it. For sterilization of my knife, I simply hold it for sixteen to twenty seconds

in the water under which the gas has just been turned off, so that the water is at boiling temperature but not actually boiling. Most killing or cooking processes are accomplished well below the boiling point. It is my opinion that most imflammatory processes which one sees after operations on the eye are due to some variation in surgical technic rather than to active infection; this, I believe, is especially true of the slow inflammatory processes. Any foreign material or any trauma will favor bacterial infection. I do not believe any ophthalmic surgeon ever performs two successive operations in exactly the same way. There are slight variations in technic. Some of these depend on slight variations in the anatomic structure of the individual eye, and I believe that the neatest possible surgical technic, with avoidance of undue trauma to the tissues, plays a much more important part than extreme efforts to avoid infection. Many years ago, before sterilization was given as much thought as it is today, the older Pagenstecher always passed the cataract knife between his lips just before making the incision. He said that this actually made the knife go through more easily, and he probably had no greater proportion of cases of infection after his cataract operations than most present day surgeons. The point is that under favorable conditions the eye is extremely resistant to the threat of infection. One's main salvation lies in the simplest and most straightforward possible surgical technic, with proper respect to the exact anatomic structure of the patient's eye. I appreciate the fact, however, that Dr. Post has been doing some excellent scientific work, and I very much respect what he has done.

DR. FRANCIS HEED ADLER, Philadelphia: I should like to call attention to a factor in dust-borne infections which will become of increasing importance in operating rooms, and that is air conditioning. In 1937 our new operating room was opened. My colleagues and I had no trouble from infections until the first hot week of the summer, when the air conditioning system was turned on. In that week I had 2 cases of intraocular infection. Cultures of material from one of the eyes showed colonies of B. subtilis, and the contamination was traced to the air in the room, which was heavily laden with the hay bacillus. It was discovered that the air which came through the system was passing through a chamber loaded with dust and hay bacilli. By spraying the duct through which the air is pumped with triethylene glycol, our problem was solved, and since then we have had no further infections.

DR. ARTHUR M. YUDKIN, New Haven, Conn.: From 1939 to 1945, when it was most difficult to obtain well trained assistance in the operating room and the operating teams were overworked, my colleagues and I were free from postoperative infections. It was not unusual for an ophthalmic operation to follow an abdominal operation; yet with ordinary care no infection of ocular tissue was observed. It is a miracle that more infections are not encountered after operations on the eye, for the conjunctiva cannot be sterilized properly and it is extremely difficult to free the air of air-borne infection. We observe the same operating room technic as that employed by the general surgeon. The noncutting instruments, towels, gowns, basins, dropper bottles and table covering are autoclaved under pressure. The medicaments are sterilized by the drug department daily. The cutting instruments are placed in Post's

original sterilizing solution for five to ten minutes. Post's recommendation of a system of sterilizing lamps to free the air of infective organisms is commendable, and I believe that the operating room of the future will be air conditioned and constructed so that the air can be sterilized.

DR. M. HAYWARD POST JR., St. Louis: The subject of electronic air filtration is exceedingly interesting, but I have not heard of its use in the operating room. I agree with Dr. Crisp, and I realize the truth of his comments. My experiments have demonstrated that the eye has a tremendous capacity to fight infection. Although my associates and I had 77.77 per cent contamination at the close of operation, the hospital records in the past have shown relatively few infections, about 0.1 per cent, with approximately 600 intraocular operations performed annually. However, if we can reduce that percentage to zero, we are making a definite advance. I might also cite in this connection our experience when Colonel Smith demonstrated his intracapsular operation for us in 42 cataract extractions in one afternoon. During those operations he smoked no less than four cigars; there were various complications, but no infections. I attribute the lack of infection at the hands of the older operators to the fact that they were careful not to touch the tips of their instruments, and that they used fewer instruments. In reply to Dr. Adler's comment, I would say that I have read merely an abstract of my paper. In the complete paper, air sterilization with triethylene glycol and ultraviolet radiation is discussed, and ways are suggested in which they may be used with safety. Much remains to be done on that subject before the entire answer is known.

Corneal Section with Long Bevel and Conjunctival Flap for Cataract Extraction: Preliminary Report. DR. WALTER S. ATKINSON, Watertown, N. Y.

This paper was published in full in a previous issue of the ARCHIVES (**35:** 335 [April] 1946).

DISCUSSION

DR. DERRICK T. VAIL, Cincinnati: Although one does not have all the reasons for the complication of reopening of the wound after cataract extraction, one can be certain that when the wound reopens one of two things happens: either a hemorrhage into the anterior chamber occurs as the result of rupture of the newly formed blood vessels, or a prolapse of the iris takes place. I must confess, however, that I am not entirely satisfied. There is evidence in the literature, particularly in a recent article by E. E. Neff, pointing to the relatively low incidence of hyphema when a preliminary iridectomy is done. Perhaps the role of the freshly cut vessels of the iris is a greater one than is usually thought. On the other hand, hyphema is not less frequent after a simple extraction or after a small peripheral iridectomy.

What causes the wound to reopen and how to prevent it are still unsolved problems. It is obvious that pressure from the outside is the chief factor in its production. There is evidence that an overfilling of the anterior chamber takes place on the fourth or fifth day after operation, signifying relative glaucoma. I am particularly wary in the case in which the anterior chamber is deeper than normal during the first week

after operation. A slight excess in the intraocular pressure during this critical period of healing or a trivial pressure applied to the eye from any source would be enough to rupture the fresh wound. Further careful studies and comparisons of the various types of corneal and corneoscleral-conjunctival incisions may give more information. It is known that there is more vascularization when the sclera, and particularly the conjunctiva, is involved in the incision. Although Dr. Atkinson's tables are significant and valuable, the series is too small to permit conclusions. One or two hemorrhages more or less would have altered his percentages impressively. When one considers, however, the serious complications that arise from delayed wound healing, leakage and collapse of the anterior chamber, one is impressed with the necessity for the use of corneoscleral sutures. It is hoped that Dr. Atkinson and others will persist in their precise studies and continue publication of their statistics.

DR. JOHN H. DUNNINGTON, New York: The technic now advocated by Dr. Atkinson is one that should receive serious consideration, for early restoration of the anterior chamber is the greatest preventive of future trouble. Use of the conjunctival covering for the entire incision is greatly to be desired and its value widely appreciated, as is the necessity of firm closure of the wound. Corneoscleral sutures are generally accepted safeguards, and most surgeons agree with the author that it is safer to place them prior to opening the eyeball. If intentional beveling of the incision lessens the frequency of a leaky wound, then by all means it should be used. In my opinion, further experience with a larger series of cases is necessary for the proper evaluation of this type of incision. I should like to ask the author whether he thinks that such a beveled incision increases the amount of astigmatism. Attention to minutiae combined with great operative skill is evidenced by the excellent results obtained in these series of cases, and I believe these factors are much more important than the beveling of the incision.

DR. BURTON CHANCE, Philadelphia: I suppose the method of cataract extraction will be a subject for discussion as long as humanity exists. I wish to refer to the method practiced by the late Dr. Edward Jackson. In the time that I was assistant at Wills Hospital, I had the opportunity of observing the methods of many operators. In my last weeks Dr. Jackson had a "cataract month," operating every day. He used a knife combining the features of the triangular Beer knife and of the Graefe knife with which he incised a rather wide bevel—only rarely with a conjunctival flap, and never with a suture. For those thirty-one days I had Dr. Jackson's patients under the closest observation, and his results were uniformly beyond what others obtained; on the average, the patients left the hospital at the end of one week. I suppose I had the opportunity of seeing every cataract method in vogue at that time, so I have spoken in praise of Dr. Jackson's beveled incision.

DR. HAROLD H. JOY, Syracuse, N. Y.: The keratome section is a rational procedure in cataract surgery. It results in a more firmly closed wound than that produced by the Graefe incision, and an increase in length of bevel increases the firmness of closure. I agree that a tightly closed wound requires direct coaptation of its margins and that this is more often obtained with the McLean suture than with the Stallard suture. I should like to ask Dr. Atkinson for his impression as to the

relative importance of the type of section and of the type of suture in preventing the complications of leaking wounds and hemorrhage into the anterior chamber.

Conceding that the incidence of filtration and hyphema is lessened by the use of the long bevel section, it is essential to know whether it is technically practicable. With this procedure, the wound is not so large as it seems and is complicated by the presence of the corneal shelf. As Dr. Atkinson stated, this ledge necessitates tumbling of the lens and offers potential difficulty in case of rupture of the capsule. I believe this point should be emphasized, for, while the incidence of unintentional rupture may not be large, it is important to consider any additional risk involved in cataract extraction. In the presence of a fairly wide ledge, jamming of the nucleus beneath it might be embarrassing, particularly if vitreous appeared. Also, it might interfere with an iridectomy and favor incarnation of the pillars of the iris. I have used Dr. Atkinson's technic in 24 cases. Thus far no serious postoperative complication has appeared. From my limited experience with Dr. Atkinson's technic, it is my impression that it is a feasible and safe procedure for the average ophthalmic surgeon.

Dr. James W. White, New York: I observed several of Dr. Atkinson's patients last summer in Watertown. I saw 1 patient in his office who had been operated on some time before, with vision of 20/20 or better and a round pupil. She was a satisfied old lady with a beautiful result. I later went to the hospital with Dr. Atkinson and saw 7 patients in the ward, all but 1 of whom were sitting up, within the week after operation, and they all looked very nice, quiet and in no trouble whatever. I then went to the hospital operating room and saw Dr. Atkinson remove a cataract by the method just described. I cannot imagine anything going more smoothly. There were no complications; the lens was removed in capsule.

Dr. Alan C. Woods, Baltimore: I am in full agreement with Dr. Atkinson's general observations. There are two points which I should like to emphasize: 1. With the McLean suture it is necessary to have the corneal section in the right place; otherwise, one will cut the sutures. 2. With the McLean suture one can get any degree of beveling desired simply by increasing the angle of the Lunsgaard knife with which one makes the primary incision at the limbus. It has been my experience that the large bevel in the center increases the difficulty of doing the iridotomy, and there is also the chance of the lens being caught on the edge of the bevel as it tumbles. I should like to ask Dr. Atkinson whether, in his figures on leaky wounds, he includes the frequent loss of the anterior chamber which occurs on removal of the suture. This is one of the definite drawbacks to use of the McLean suture, and in my experience it has a rather high incidence, probably 2 or 3 per cent of cases. It is usually a trivial thing; it corrects itself, and the chamber reforms in a day or so.

Dr. Lawrence T. Post, St. Louis: Having been troubled considerably by late hemorrhage and having become convinced that it was chiefly due to the breaking of new-formed vessels in the incision from the fourth to the tenth day after operation, I changed my technic somewhat by dissecting down the corneal flap well onto the cornea, so that I could see a clear, avascular area of cornea of about 0.5 mm., or perhaps

even as much as 1 mm., at the limbus, and making the section through this area. Since adopting this procedure, I have found the incidence of late hemorrhage to be gradually reduced.

DR. WALTER S. ATKINSON, Watertown, N. Y.: Since submitting this paper, I have done 46 more extractions by this method, making a total of 96 for group 3 (cases in which a conjunctival flap was first made). The percentage of shallow chambers and small hemorrhages was essentially the same as that for the first 50 cases; so in the 96 cases of group 3 there were only 1 case of empty chamber and 1 case of hemorrhage large enough to prolong the patient's stay in the hospital. Some one called attention to the small percentage of cases in which vitreous presents. Unfortunately, in the last 46 cases there was 1 case in which vitreous presented, making a little over 1 per cent for the series. With regard to the astigmatism, the averages for the three groups do not vary greatly.

Dr. Joy has asked my impression of the relative importance of the section and of the type of suture in the prevention of leaky wounds and hyphema. Both seem to be of considerable importance, but a long-beveled section in corneal tissue completely covered with a conjunctival flap impresses me as of more importance than the type of suture used. Introduction of the suture before the section is preferred, principally because it is safe. Furthermore, it is desirable to have the interval between the section and the extraction as short as possible, so that the pupil will not contract and make it necessary to do an iridectomy. The suture, however, may be introduced safely just after the keratome incision, and before the wound is enlarged with scissors. In this manner, secure closure with good approximation may be obtained.

In regard to Dr. Woods' comment, no iridotomy was done in the cases in which the corneal ledge covered the iris. In group 3, there was only 1 case in which the chamber was not reformed at the first dressing. Oftener the chamber became shallow later, about the fourth or the fifth day. Occasionally a shallow anterior chamber was observed after the suture was removed. In the cases of group 3 the suture was removed about the twelfth day. If the suture was tight, so that the point of the scissors could not easily be introduced under it, a small, sharp Bard-Parker knife was used. In doing it this way, the knot is first pulled up a little with forceps so that the cutting edge can be drawn across the suture just back of the knot. The suture is not held with the forceps while it is being cut. All have learned how dangerous this is.

Technical Uses of Air in Ophthalmology. DR. WENDELL L. HUGHES, Hempstead, N. Y., and (by invitation) DR. J. GORDON COLE, New York.

This paper, with discussion, was published in full in a previous issue of the ARCHIVES (**35:** 525 [May] 1946).

Relationship of Rubella in the Mother to Congenital Cataract in the Child. DR. EVERETT L. GOAR and (by invitation) DR. CHARLES R. POTTS, Houston, Texas.

Seven cases of congenital cataract were presented, in all of which the anomaly was accompanied with other defects, usually a congenital

heart lesion, poorly developed musculature or retarded metality. In 6 of these cases the cataract was bilateral; in 1, unilateral. Six of the 7 mothers had rubella in the early months of pregnancy. One whose baby had the syndrome gave no such history.

The cataracts were typical in that the embryonic nucleus, which develops soon after the fibers are laid down, was affected.

Five of the patients had both eyes operated on, with use of ether anesthesia. The through and through discission advocated by Ziegler was done. Fair results were obtained in all cases. Secondary glaucoma did not occur.

It is considered wiser to operate on these infants within the first two or three months, before nystagmus begins.

DISCUSSION

DR. ALGERNON B. REESE, New York: Dr. Goar and Dr. Potts present a longer period of observation in these cases than I have encountered before. They have observed that the cataract is characterized by a central, densely opaque disk, surrounded by a more or less transparent cortex. It has been my experience that this central disk can, and should, be removed from within the confines of the capsule and allowed to rest in toto or fragmented in the anterior chamber at the time of the needling operation. If the nucleus is extruded like a pea from a pod and rests in toto in the anterior chamber, it will absorb readily. If the central disk is removed from the capsule, there is little additional soft lens matter for absorption, and a black pupil is achieved in a shorter time than is usually the case with other types of congenital cataract.

I agree that the patients stand ether anesthesia well in spite of the heart lesion.

It is possible that the offending disease in these cases is other than rubella, which I am told by authorities is a pleomorphic disease, and a rather loose entity.

Dr. Frank Payne and I are studying cases of retrolental fibroplasia. We have been impressed with the number of mothers of the patients who give a history of bleeding, fever or some other irregularity during pregnancy. Children whose mothers are thought to have had a subclinical infection with the toxoplasma may have congenital anomalies. These observations may implicate infection in early pregnancy as a most important factor in the malformation of the embryo, and thereby open a new vista in the field of congenital anomalies

DR. FREDERICK C. CORDES, San Francisco: My colleagues and I have seen 10 cases in which rubella was contracted by the mother during the first three months of pregnancy and in which the infants had cataract formation, as well as other typical changes. In this series were 2 cases of monocular cataract in which the retina of the noncataractous eye was good and vision was present, but ophthalmoscopic examination revealed fine particles of pigment clumped and scattered throughout the fundus, being most prominent in the foveal area. The pigment was in the retina. The disk was pale, but the arteries were not contracted. Except for the vessels, the picture suggested retinitis pigmentosa.

Also of interest was the case of a girl of 9 years whose mother had rubella during the second month of pregnancy. The mental age of the child was 2 years. At birth she had weighed 4 pounds (1,814 Gm.)

and was ill nourished and difficult to feed. Bilateral cataract was present at birth and operation was performed at the age of 3 years, with fair visual results. From this experience it appears that cases of this condition have been encountered in the past, but the etiologic factor had not been established, so that the defect was not recognized as an entity.

After therapeutic curettage, an 8 week embryo with a history of rubella during the sixth week of embryonic life was obtained. The lens of the eye shows definite retardation. This observation indicates that changes in the lens do occur at the time of the infection with rubella. It has been shown that the filtrable viruses may be found in the amniotic fluid. The absence of protection of the lids and of Descemet's and Bowman's membranes during the first three months of embryonic life may permit toxic agents in the amniotic fluid to act directly on the lens. The presence of these barriers after the third month may explain the absence of the changes in the lens when rubella is contracted during the latter part of pregnancy. The study of more specimens is necessary before these observations can be evaluated.

Dr. Lawrence T. Post, St. Louis: Dr. Goar has cited me as having advocated local anesthesia for operation on infants with this defect. Experience in 2 cases certainly does not permit one to do more than suggest. In my first case I performed the operation with the patient under ether anesthesia; the patient died the following day. Whether the anesthesia was in any way responsible I do not know; but, certainly, it was an added insult to a subnormal child. In the next case I used instillations of cocaine, as for a needling operation in an adult. The nucleus was easily tipped into the anterior chamber and sliced into sections, as described by Reese. This baby is still alive, one year later, and has clear, aphakic pupils but is mentally and physically retarded.

A second point to be considered is whether or not cataract followed rubella in mothers prior to the epidemic in Australia in 1941-1942. It is not unlikely that this particular epidemic of rubella, which later reached the United States, possibly from Australia, was one in which the peculiar sequelae of cataract, congenital heart lesions and disturbances of the central nervous system were important features, not often present in other epidemics. If the syndrome had occurred frequently before, it is more than probable that it would have been noted.

A practical question is whether abortion should be induced in mothers who have rubella in the first two months of pregnancy. I believe that this should not be advocated by the ophthalmologist, for the following reasons: (1) The diagnosis of rubella is not certain; (2) there have been cases in which normal children have been born in spite of the rubella, and this will continue to occur; (3) it is not rare that after an induced abortion there will be no subsequent pregnancy; (4) it is questionable whether there is good ethical background for inducing abortion in cases of this sort in which there is only the prospect that the mother may produce an abnormal child; (5) the ophthalmologist would be counseling the performance of a questionable procedure by some one else, that person of necessity having to take the major share of the blame if the outcome was not as successful as was hoped.

Dr. E. C. Ellett, Memphis, Tenn. (discussion read by Dr. R. O. Rychener, Memphis): After the publication of Gregg's report, the

history of the occurrence of rubella in the mother in the early months of pregnancy was investigated in 10 cases of congenital cataract. In 4 of these cases there was a positive history; in 1 case, a history of measles, and in 1 case, a severe attack of influenza. In most cases the children were poorly developed; in 3 there was congenital heart disease, and in 1, clubfeet. In 1 case the patient was an adopted child for whom no history was obtainable. The anesthesia was without incident in all cases in which a general anesthetic was used, and the surgical aspects presented nothing different from those in similar cases.

DR. JOHN GREEN, St. Louis: I saw a case of this type in consultation. The baby, though not premature, weighed only 3½ pounds (2,087 Gm.) at birth. The feature which interested me particularly was that this baby had delicate posterior synechias in one eye. There was no ciliary congestion; but, because of the presence of adhesions, I counseled a delay of several months before operation.

At operation my colleague encountered some difficulty on account of the extremely small size of the eye and planned to have a very small discission knife made for use on the other eye.

DR. T. L. TERRY, Boston: A brief summary of the changes in the eyes observed at autopsy in an infant who died at 4 months of age, the mother having had rubella late in the third month of pregnancy, should not detract from the formal report that is being prepared. The most striking changes were in the crystalline lens of each eye. These were seen only on careful microscopic study with subdued illumination. 1. The individual lens cells were preserved in the fetal nucleus. One could make out dimly the nuclei of these cells, although they appeared somewhat "ghostlike." No keratinizing process was present in the center of the lens nucleus of either eye. 2. Surrounding the nucleus were groups of rounded and irregular, basophilic globules, the arrangement and appearance of which were similar to those seen in lamellar cataracts of tetany. 3. The fetal nucleus in each eye was located far forward, with practically no cortical material between the nucleus and the anterior lens capsule. This abnormal position of the fetal nucleus appears to have resulted from the inability of the lens fibers, growing after the nuclear and perinuclear injury, to insinuate themselves in front of the fetal nucleus. The newly formed fibers tended to be arranged in irregular layers, and even concentric whorls. There were also some scattered mild cataractous changes in the cortex.

The fetal nucleus measured 1.5 mm. in diameter, which corresponds rather closely to the normal size of the entire lens at the latter part of the third month of embryonic life.

It may be characteristic in cases of maternal rubella for the lens nucleus to become changed in its position within the crystalline lens, as the microscopic sections seem to indicate. I have seen 2 other cases in which that did occur.

Why the cataract may be unilateral is another unexplained problem. In the retina of the noncataractous eye there were pigmentary changes minute in size and, as Dr. Cordes has said, similar in form and distribution to those of retinitis pigmentosa, although I do not intend to infer that this condition is related to retinitis pigmentosa.

This association shows that "maternal impression" really does exist, but the condition results from a physical, rather than a psychologic, trauma. The damage begins at the time at which the embryo is most susceptible. The injury may be derived from the toxins, from the increased temperature or from infection with the virus itself.

It should be mentioned, also, that one can now indicate to the parents of infants who have rubella cataract that the ocular disturbance is not hereditary.

DR. WENDELL L. HUGHES, Hempstead, N. Y.: I should like to ask whether the authors have seen any cases of unilateral congenital cataract in the babies of mothers who have had a typical history of rubella at the proper time, that is, at the three month period of gestation.

DR. C. A. CLAPP, Baltimore: I should like to ask the authors whether they interrogated the mothers as to the occurrence of other types of infection during the early months of pregnancy. I feel that possibly any type of infection or toxemia in the early months of gestation may cause lenticular changes.

Of the last 6 cases of complete congenital cataract which I have seen, and in which I have questioned the mothers carefully as to any illness during early pregnancy, I have found that there was no history of any indisposition in 5 but in the sixth scarlet fever occurred during the second month of pregnancy. In no case could I obtain a history of rubella.

DR. ALAN C. WOODS, Baltimore: I think there is no question as to the establishment of this clinical entity. It brings up several interesting points, however, one of which Dr. Post has emphasized. I have had 3 pregnant patients sent me with the request that I sign a slip stating that a therapeutic abortion is justifiable on the grounds that these prospective mothers had rubella early in pregnancy. I was a little suspicious that these mothers might be using their history of rubella as a means of getting rid of unwanted progeny. What is known is that a number of mothers of babies with the syndrome of cataract, cardiac malformation and disturbance of the central nervous system give a history of rubella early in pregnancy. What is not known is the percentage of mothers who have had rubella who will produce this type of progeny. I think there is a grave question whether 100 per cent of such mothers will produce these defective children. The question is of such interest that Dr. Cormer, head of the Carnegie Institute for Embryology, is contemplating a long range and extensive study on monkeys to determine the effect on the offspring of rubella early in pregnancy.

DR. EVERETT L. GOAR, Houston, Texas: In reply to Dr. Post's comment, we are not advocating therapeutic abortion. I believe that if we could say positively that every mother who has rubella during the first few months of pregnancy would have a baby of this sort we would be justified in advocating therapeutic abortion, for these infants are the most miserable I have ever encountered. In the light of present knowledge, however, such a stand would put us in a disadvantageous position, because we cannot prove it.

I believe that the slides which Dr. Cordes and Dr. Terry have shown demonstrate that this cataract is not a truly inflammatory affair. This

picture coincides with the clinical appearance, because these children do not have the dense posterior synechias familiar in children who have cataract from intrauterine inflammation.

Dr. Clapp, we interrogated the mothers as to other forms of infection, and we could get no history of maternal infection except for rubella.

In regard to the question of these cataracts being unilateral, in 1 of the 6 cases it was unilateral. Why that should be so when it is undoubtedly a constitutional condition is difficult to say.

The Vossius Ring. MAJOR TRYGVE GUNDERSEN, Medical Corps, Army of the United States.

The author reports 19 cases of Vossius ring, all having occurred as a result of battle injury in young American soldiers. In every case intraocular hemorrhage was present. The size of the ring was practically constant, 2.25 to 2.75 mm. being the limits of variation in the diameter. It is concluded that the ring does not consist of iris pigment left behind on the lens capsule as a result of the injury, but that the most tenable explanation for its formation is the deposition of blood pigments from the aqueous in characteristic fashion during the interchange of fluids through the anterior lens capsule.

Persistence and Hyperplasia of the Primary Vitreous. DR. ALGERNON B. REESE, New York, and (by invitation) DR. FRANK PAYNE, New York.

This is a report based on 50 cases of persistence of the primary vitreous. The authors feel that the lesion represents the congenital remains or persistence of embryonic tissue and, therefore, is not essentially an acquired one. Secondary complications may be hemorrhage, cataract, corneal changes, glaucoma and detachment of the retina. Hemangioma seems to be closely related to persistence of the primary vitreous, both conditions consisting of congenital remains of angioblastic mesoderm. Treatment is not altogether satisfactory.

DISCUSSION

PROF. IDA MANN, Oxford, England: These cases are all good examples of the general principle of the production of developmental anomalies through arrest at a definite stage of intrauterine or extrauterine life, followed by aberrant growth. This aberrant growth may lead to excess normal tissue or, by atypical differentiation of pluripotential cells, to the appearance of tissue abnormal in that situation, e. g., cartilage and unstriped muscle in the posterior vascular capsule. That prematurity is often a feature of these cases is not surprising, since the interference with development seen in the eye may be part of a general aberration, manifesting itself both as prematurity and in various associated malformations. The primary cause of the whole clinical picture is likely to be a maternal upset, probably nonspecific in nature but specific in time. That this can happen has been shown by many experimental embryologists and is now known to occur in man, e. g., in cataract due to rubella and in the maldeveloped retinas of fetuses roentgenographed in utero. I suggest to Dr. Reese that it would be more helpful if he

would consider classifying his cases not on clinical findings alone but on the probable stage in development at which the initial arrest occurred. Judging the cases from a purely embryologic standpoint, I should say his type 1 begins earliest, probably at about the 15 mm. stage, certainly before the end of the organogenetic period. His type 3 is also early, beginning certainly before the third month, and is allied to congenital retinal septum, which can also be explained as a localized linear failure of secondary vitreous. Type 2 probably begins between the fifth and the sixth month, as there seems to be an accompanying arrest of formation of the angle of the anterior chamber, while the cases of type 1 in which glaucoma subsequently develops arise possibly only a little later. Type 4 is obviously related to an arrest at the very end of fetal life.

This classification could be checked and amplified if accurate data could be obtained of the time of the maternal upset, as evidenced by the occurrence of bleeding and of infections of the respiratory tract noted in 14 of the mothers. The cases would then probably be seen as a continuous series rather than as sharply differentiated types.

DR. F. H. VERHOEFF, Boston: In specimens sent me for examination by the Army Medical Museum, I have seen all the conditions described by Dr. Reese. I should like to ask him whether he has ever seen hemorrhage extending from the retrolental tissue into the lens; I have seen this in at least 1 case.

DR. HENRY HADEN, Houston, Texas: I agree that the term persistence and hyperplasia of the primary vitreous is appropriate for the congenital abnormalities under discussion. The primary vitreous is composed of mesoderm which flows in between the rim of the optic cup and the lens, the mesoderm that accompanies the hyaloid artery as it passes through the fetal fissure into the optic cup and ectodermal fibers derived from the lens and the inner wall of the cup.

Toward the end of fetal life the mesodermal part of the vitreous disappears, and the permanent vitreous is exclusively ectodermal in origin. In certain circumstances, a portion of the mesodermal tissue is not absorbed, and a variety of lesions, such as Dr. Reese and Dr. Payne have described, are the result. The size, position and style of the lesion are influenced by the fetal age at which the normal recession of the primary vitreous ceased.

DR. T. L. TERRY, Boston: That Dr. Reese and Dr. Payne hold certain views in disagreement with mine is encouraging. Their belief that the abnormal development occurs before birth is the most important difference. The evidence is based on 1 instance, in which the infant, weighing 3 pounds 5 ounces (1,500 Gm.), was observed on the day of birth to have the disease process well developed. Warkany has proved that in the young born of rats in an extreme stage of vitamin A deficiency abnormal eyes develop early in gestation. I have confirmed his observations. Chief among these abnormalities is the growth of mesodermal tissue in the meshwork of the tunica vasculosa lentis, behind the lens. Although such extreme depletion of vitamin A is not likely in the human mother, it could cause such a sequence of events. It may account for the lesion on which Dr. Reese and Dr. Payne base their conclusion of intrauterine development of the process in their most dramatic case.

The process can, and does, develop during intrauterine life. It has been observed in full term infants at time of birth. Although this is probably a process identical with that seen in the premature infants, I do not yet have proof that the two are identical. I should expect the ocular defect to manifest itself at birth, or very soon thereafter, in premature infants nearing term, whereas in the infants weighing 3 pounds (1,360 Gm.) or less it would not appear for weeks, or even months.

A routine study of the eyes of premature infants, followed from the day of birth to a time when all danger of development of retrolental fibroplasia has passed, has shown me that this disease process can, and does, become manifest in some premature infants after birth. Clifford and I have not been able to determine during their incubation in which premature infants retrolental fibroplasia will develop, but Clifford has shown that in about 12 per cent it will develop several weeks or months after birth.

According to Clifford, the only associated defect is a lack of mental development in some of the infants. I have observed angioma in 17 cases. I have not found any statistics showing the frequency of angioma in infants as a whole, although I am told that it is high.

A less important difference in our views is that of terminology. The disease, I believe, represents a growth of embryonic connective tissue in the meshwork of the closed tunica vasculosa lentis, which reopens before its lumen has become impervious. I say "reopen," for the vessels of the tunica vasculosa lentis system had previously been observed when the eyes of extremely premature infants were first examined and had become invisible when they stopped carrying blood. The abnormality is not a persistence of the vascular tunic in its embryonic and early fetal state in a region where no such solid tissue is ever encountered during normal development. Thus, I object to the word "persistence," which the authors suggest. I consider primary vitreous to be the total mass of mesodermal and ectodermal syncytium between the lens and the retina up to the 40 mm. stage. That blood vessels are a part of it I do not agree, although blood vessels for a time pass through it and perhaps contribute to its early growth. When these vessels disappear, I do not visualize the primary vitreous changing over to secondary vitreous; rather, it persists throughout life as the less viscous material filling the so-called retrolental span and Cloquet's canal. With this view Prof. Ida Mann told me she was in agreement. If it is correct to consider the hyaloid artery and tunica vasculosa lentis as an integral part of the primary vitreous, then the name "hyperplasia of the primary vitreous" loses much of its objection to me. Primary vitreous reaches its full growth at the 40 mm. stage. If the retrolental fibrous proliferation represents a hyperplasia of the primary vitreous, even though it does not permeate the vitreous of these small eyes, it represents a very great hyperplasia indeed.

Exception might be taken to the length of the name suggested by Reese and Payne. Of all the terms formerly used, "fibrovascular sheath" is probably the least objectionable; but it does not locate the disease process in any one organ of the body or in any position in the eye, as does "retrolental fibroplasia."

Because of the slow manner in which the lens material is absorbed after discissions, I have been eradicating the lens by a linear extraction associated with an iridectomy above and an iridotomy below, in an attempt to prevent blocking of the pupil. I have used this operation only when the anterior chamber is absent, lentocorneal synechias are present and central corneal opacities are developing. Careful suturing of the wound permits the retention of injected air in an attempt to prevent recurrence of the anterior synechias. After the operation an adequate anterior chamber is usually present.

DR. ALGERNON B. REESE, New York: We stated that our classification was purely a clinical one and one adopted for convenience. Professor Mann's idea of making the classification include the stage at which the maldevelopment in the embryo occurs is well worth while.

Dr. Verhoeff mentioned the relationship to hemangioma. I stated that our conception of a hemangioma is that it represents a congenital rest of angioblastic mesoderm which later begins to grow into a neoplasm. It does not behave like a true neoplasm clinically, because angiomas do not as a rule have the capacity for unlimited growth. We have never noted hemorrhage extend from the retrolental tissue into the lens, as Dr. Verhoeff has.

We believe this lesion to be congenital, irrespective of whether it occurs in premature or in full term infants. The matrix of the lesion is present at birth, with varying degrees of hyperplasia subsequently. This interpretation is not based solely on 1 case, as Dr. Terry stated, but depends on several factors: 1. In premature infants the lesion was observed at birth in 1 case and at less than 1 week of age in another; in full term infants the lesion was noted at birth in 3 cases and at the age of less than 1 week in 4 cases. The clinical and pathologic features appear identical in the two groups. 2. The hyaloid artery, if absent at birth, never develops later; rather, if it is observed it was necessarily present at birth. The hyaloid artery is always a congenital manifestation, and it is frequently associated with the condition under discussion. 3. The various tissues seen in these lesions originate from mesoderm; mesoderm does not form after birth.

Dr. Terry disagrees somewhat with our conception of the primary vitreous. It seems to me our views in this regard are those generally advanced by embryologists. Irrespective of names, there certainly occurs in embryonic life an angioblastic mesoderm inside the eye, and normally this disappears. When it persists and becomes hyperplastic, we believe it gives rise to the various lesions described in this general group.

Exposure and Fixation of the Eye in the Early Days of Cataract Extraction. DR. BURTON CHANCE, Philadelphia.

This paper was published in full in a previous issue of the ARCHIVES (**36:** 484 [Oct.] 1946).

Ocular Imagery. DR. ALFRED COWAN, Philadelphia.

This paper was published in full in a previous issue of the ARCHIVES (**35:** 42 [Jan.] 1946).

DISCUSSION

DR. F. H. VERHOEFF, Boston: Many years ago I published a paper entitled "Cause of a Special Form of Monocular Diplopia," in which I explained how monocular diplopia was produced by spherical aberration combined with astigmatism. I pointed out that there were other phenomena due to monochromatic aberrations of the eye. Such aberrations explain why a given amount of astigmatism does not always reduce visual acuity to the same extent. An unusual amount of accommodation in senile eyes and of so-called accommodation in cases of aphakia are similarly explained. There are many irregular aberrations to be considered, which may lead to serious errors in the determination of regular astigmatism.

DR. WALTER B. LANCASTER, Boston: Dr. Cowan and I agree as to fundamental principles; yet we reach different conclusions.

We are in agreement with respect to Gullstrand's statements. It seems to me that Dr. Cowan's quotation from Gullstrand and my position are fully in agreement. The only possible grounds for charging a misunderstanding on my part is that I assume that Gullstrand meant what he said, possibly with slight exaggeration for emphasis, while Dr. Cowan thinks Gullstrand did not really mean what he said. However, Dr. Cowan only makes clearer than ever that Gullstrand, dissatisfied with fictions and approximations, discarded the Gauss theorems as a guide to image formation and devised a more accurate and more useful approach.

As a matter of fact, I make two reservations and go a little farther than Dr. Cowan does. Several years ago I stated that, in spite of Gullstrand's statement that the conoid of Sturm did not even approximate the path of the rays in an astigmatic eye, it was, in my opinion, only in so far as it did approximate that form that one is able to correct astigmatism. One is dealing with approximations, and so formulas which are only approximate may be useful in aiding the understanding of what is often made an intricate problem. In this reservation about the conoid of Sturm Dr. Cowan and I are in substantial agreement.

The second reservation I should make is that the Gauss theorems cannot be cast aside, for they have immense historic interest and no ophthalmologist can be regarded as well educated who is not familiar with them in a general way. Here, again, Dr. Cowan and I are nearly in agreement.

But experience has shown that the average good ophthalmologist does not use the Gauss equations in his daily work and has the crudest notions of image formation and the vaguest ideas about the significance of aberrations. Therefore, I feel justified in saying that the subject of visual optics has not been well taught. This is our first major difference, a difference with respect to where the emphasis should be placed in teaching visual optics: whether on the laws of refraction and the behavior of light waves or on image formation.

We differ in other conclusions. A closer examination reveals that the major part of the paper is devoted to the old controversy about refraction with drops. I take issue wth Dr. Cowan when he states: "A large pupil has little or no effect on the distinctness of the useful retinal image as long as the system is properly in focus, whether normally, by the accommodation, or by the aid of a lens"; or "In any subjective

examination a wide, inactive pupil is a distinct advantage," and when he says of Gullstrand's and other investigations of image formation, "The findings of all such investigations are very interesting academically," implying unimportance practically.

Speaking of how the eye deals with the confusion circle, of which Gullstrand makes so much, Dr. Cowan states that "since sharp vision is obtained only in the vicinity of the fovea, that part of the convergent pencil which best answers the purpose will be selected." The reason is that it gives the best image. That part of the confusion circle which has to be disregarded is disposed of or suppressed, not because it falls on the periphery of the retina, but because with the illuminations ordinarily used much of that part of the blue circle is below the threshold of vision. This is what Gullstrand has made so clear and convincing.

Dr. Cowan appears to be inconsistent or self contradictory in some of his statements. Thus, he says that the aberration of any optic system increases with the diameter of the aperture; then he denies that this applies to the eye. One of the chief functions of the pupil is to improve vision by excluding the extremely aberrant peripheral rays. He then admits that the large pupil introduces difficulties in subjective refraction. He says that "theoretically, no method of refraction, objective or subjective, is absolutely reliable with an active pupil." I retort that no method of refraction is reliable with a dilated pupil, either theoretically or practically.

In the unmasking of latent hypermetropia, cycloplegia has a value. This value is greatly exaggerated, (1) since actual spasm of the accommodation, for which it is especially recommended, is so rare that Hess, Hirschberg and others of enormous experience say that they have never seen a case, (2) since there are other ways which succeed in the majority of cases, (3) since cycloplegia as ordinarily practiced is incomplete and (4) since cycloplegia introduces other sources of error—the aberrations.

My first teacher of refraction, Mauthner, of Vienna, stated emphatically that if a man could not measure the refraction without using "drops" he was not competent to practice refraction. Nevertheless, I adopted the use of cycloplegia myself and have always advised beginners to use it. After several years, I found I could dispense with "drops" in some cases. Thus, my personal experience (not an isolated one) proved to me that the simple theory on which cycloplegic refraction is based has serious flaws. Just as an understanding of the conoid of Sturm has proved invaluable in the measurement of the astigmatism, so an understanding of the caustic and its importance in selecting the focus for best vision is invaluable in measuring hypermetropia and for the final choice of correcting lenses. In emphasizing, as I do, the advantages of measuring the refractive errors of the eye without cycloplegia, no one should assume that that method is the only one I ever use or recommend.

I was surprised at something Commander Young told me about his experience in the Navy. He had to train experienced optometrists and girls who had had no training whatever. A knowledge of theory was not necessary for these persons to make refractions; therefore it seems to me that my fundamental thesis has not been refuted, namely, that the present method of teaching physical optics and refraction is not satisfactory.

DR. W. H. CRISP, Denver: It is advisable for the practical refractionist to know that the eye is an imperfect optical instrument. The limitations of ocular optics constitute the most important reason for the incomplete reliability of retinoscopy as a final basis for prescribing glasses. But the practical refractionist does not need to delve very deeply into these mysteries.

In some discussions as to the size of the pupil it is assumed that the eye always uses the entire pupillary area. This cannot be the case, for the overlapping images produced by different parts of the pupillary area would otherwise often create confusion in the image impressed on the brain. There is excellent ground for assuming that nature usually selects a limited area of the pupil for purposes of definition and in some mysterious and wonderful way ignores the overlapping images produced by other parts of the same pupil.

In retinoscopy it is important to realize that as soon as glass lenses are placed before the patient's eye it becomes impossible for the examiner to look exactly at right angles to such lenses because of the light reflections, and that oblique observation at once introduces elements of spherical and astigmatic error.

DR. ALFRED COWAN, Philadelphia: Dr. Lancaster kindly said that we agree on fundamental principles and yet reach different conclusions, but I think we do not agree even on fundamental principles.

To answer the many points he disputes I should have to repeat nearly every statement made. I feel I have not said one thing that is not based on the scientific facts, even with regard to determination of the refraction of the eye with an active pupil. I do not agree with Dr. Lancaster's explanation of the suppression or disposal of the confusion circle; but, even if it were correct, the important fact remains that in the eye the aberration is disregarded.

I am surprised at Dr. Lancaster's relating what Commander Young told him about teaching optometrists and girls to do refractions in the Navy. I have seen some of the results of this work.

Paralysis of Ocular Elevation With and Without Ptosis. DR. DANIEL B. KIRBY, New York.

This paper was published in full in a previous issue of the ARCHIVES (**35:** 199 [March] 1946).

DISCUSSION

DR. JAMES W. WHITE, New York: In examining patients with this disturbance, it is not the paretic eye alone that should be studied. A paralysis of the same muscle or muscles will produce different effects, depending on the fixating eye. In the case of paralysis of the left inferior oblique muscle reported by Dr. Kirby, if the right eye is the fixating eye, the left eye is in a position of hypotropia; but if the left eye is chosen to fixate, the superior rectus muscle of the right eye develops a pronounced secondary deviation. If the superior rectus and inferior oblique muscles of the left eye are paretic, there will be a field of binocular single vision below. As the gaze is directed upward, if the nonparetic eye fixates, the left eye is hypotropic; but if the paretic left eye fixates, the right superior rectus has a secondary deviation in

eyes up and right and the right inferior oblique has a secondary deviation in eyes up and left. These variations are best studied with the screen test and followed with the screen comitance test, with the eyes not only in the primary position but in the different directions of gaze. The fixating eye in the primary position may be one thing; and one can never tell how this may change as the eyes are rotated from one position to another and fixation changes in the different fields.

The Wheeler operation will correct large amounts of hypertropia, depending on the fixating eye. I have tried both the splicing and the tucking operation at the insertion, and neither has given me as large an amount of correction as the Wheeler technic. Dr. Kirby, after he had resected the superior rectus of one eye and advanced the inferior oblique of the same eye, thought he could duplicate the result in the fellow eye; and he did duplicate it absolutely. In the primary position the deviation varied from a trace of exophoria to a trace of esophoria, and there was no hyperphoria. There was a normal near point of convergence, and the nystagmus was definitely reduced.

Dr. Conrad Berens, New York: Because of the seriousness of the prognosis in some of these cases, particularly in cases of young women, I wish to speak of 2 patients.

One young woman had complete paralysis of the right third nerve and had had a previous operation for ptosis which was only partly successful; her appearance was most unhappy because of the eyelid and the position of the eye. She was insistent that something be done; so I performed a resection of the superior rectus and transplanted the superior oblique muscle. I was successful in bringing the eye into fairly good position and in getting a small field of binocular fixation which she had not had previously. I subsequently raised the lid by the Reese operation for ptosis. I probably had beginner's luck, for I have not been so fortunate in subsequent transplantations of the superior oblique muscle.

Another young woman had bilateral ptosis, the result of congenital paralysis of the levator muscle of the eyelids and the elevator muscles of both eyes. The family was anxious to try something in spite of the danger to the cornea; as the patient's situation was rather desperate, a bilateral Reese operation was performed. She had only slight corneal irritation on two occasions; but by keeping the conjunctiva anointed at night with liquid petrolatum she has got along very well, is married and has two fine children.

In seeing these patients, the ophthalmologist should consider what it means to a young woman and should sometimes take a risk and operate even when it seems as though he might not be successful.

Dr. Alexander E. MacDonald, Toronto, Canada: I have a case of ptosis; there is little tarsus left, and I propose to insert a diathermy needle at the fold of the upper lid and pass it up to the margin of the orbit on two or three occasions, so as to control any overcorrection. I should like to ask whether any member of the Society has done this and, if so, what the results were.

Dr. Daniel Kirby, New York: I have been discouraged by the very appearance of patients with third nerve paralysis and have not been

attempting to operate on them. Certainly, Dr. Berens is to be congratulated on his satisfactory result.

I am opposed to the production of any deep cicatrix or sclerosing of tissues, or to anything that will produce lagophthalmos. I think that diathermy might produce some lagophthalmos in the case described by Dr. MacDonald; and there may be a distortion of the upper lid, particularly because of the small amount of tarsus remaining.

A Comparative Study of Sutures Employed in Operations on the Extraocular Muscles. Dr. Conrad Berens, New York, and (by invitation) Dr. Hunter H. Romaine, New York.

This comparative study of sutures employed in operations on the extraocular muscles includes a discussion of technical factors, i. e., ease of handling, adsorption and absorption, tensile strength and friction coefficient. The surgical procedures employed in these experiments on the extraocular muscles were limited to recession with scleral fixation and resections. The authors drew the following conclusions:

1. Cotton and silk sutures are most easily handled, the braided type being preferred to the twisted. Nylon (000000) is difficult to handle.

2. Nylon (000000) produced the least tissue reaction and had the greatest tensile strength.

3. The absorbable sutures have the advantage of not having to be removed. Plain surgical gut produces less reaction than chromic surgical gut.

4. In the presence of infection, nylon, cotton and silk sutures are preferable to surgical gut.

5. Plain surgical gut sutures (000) are sufficiently strong to attach any extraocular muscle under ideal conditions.

DISCUSSION

Dr. Philip Meriwether Lewis, Memphis, Tenn.: After having seen Dr. Romaine use nylon sutures in operations for squint, I have used double-armed 000000 nylon sutures in 20 resections and in 29 recessions. The conjunctiva in adults was closed with black silk and in young children with plain surgical gut.

A notable reduction in the amount of postoperative reaction was noticed in practically every case. I should like to ask Dr. Berens and Dr. Romaine whether, in their research on animals and on patients, they found that nylon sutures remained unencapsulated.

My only objection to the use of nylon sutures in operations for squint is that the needles are easy to bend. This bending may be avoided by grasping the needle nearer the point than is done with ordinary curved needles. A definite advantage is the ease with which the nylon sutures may be passed through the superficial fibers of the sclera in recessions.

Dr. Lawrence T. Post, St. Louis: I want to ask Dr. Berens whether with nylon sutures he has had any difficulty with slipping of the knots. There is a considerable difference in tendency to slip between twisted and braided silk sutures, the braided silk having a higher coefficient of friction and not slipping so much. It is advisable to make a double knot in the first tie when using twisted silk. I came to the

same conclusion as did Dr. Berens about chromic and plain surgical gut. Having used chromic gut for a long while, I changed entirely to plain surgical gut because of the reaction.

Dr. Avery D. Prangen, Rochester, Minn.: In the evaluation of sutures used in operations on the extraocular muscles, the questions involved are: (1) the use of plain versus chemically treated absorbable sutures; (2) the use of absorbable versus nonabsorbable sutures; (3) the use of fine versus coarse sutures, and (4) the absorbability of sutures, which the authors have considered.

Until ten years ago I used various types and sizes of silk sutures, even twisted and waxed sutures and reenforcing gold plates; but I was far from satisfied. Reactions were too common and too severe. At times sloughing and slipping of sutures occurred. Finally, the sutures had to be removed, a procedure often more difficult and painful than the original operation. At the suggestion of the late Dr. P. C. Jameson, I turned to surgical gut sutures, which eliminated these objections. I am still using fine 000 to 0000 plain surgical gut sutures.

I have had no experience with nylon sutures. I prefer to use the absorbable sutures, which do not have to be removed.

It seems that tensile strength and size of surgical gut sutures are not related to their holding power. Also, I find that plain surgical gut sutures hold as well as chemically treated surgical gut sutures; and the plain sutures cause much less reaction. It has been my experience that plain surgical gut sutures do not slip. Fortunately, infection has played a minor part in my cases for the past twenty-eight years. I have lost only 1 eye, from a low grade endophthalmitis.

From the authors' report it would seem that either small plain surgical gut or nylon sutures are preferable. I prefer plain surgical gut sutures of small caliber because they do not have to be removed. With all knots tied outside the conjunctiva, a minimal amount of suture is left buried to cause reaction. It could well be that fine nylon sutures would be preferable in selected cases.

Dr. Edmund B. Spaeth, Philadelphia: There are two observations of Dr. Berens and Dr. Romaine which confirm long clinical experience. The first is the unsatisfactory tissue reaction to the use of chromic surgical gut in operations on the extraocular muscles. It seems that use of this suture should be discontinued for any such operations. The principal complications are (1) reaction of the muscle and conjunctival tissue about the sutures, (2) delay in absorption of the knots and scleral sloughs and (3) unwanted scleral reactions.

The second point of interest is the matter of tensile strength and, with it, the size of the suture. It is known clinically that braided silk sutures are much easier to handle mechanically than are the twisted silk sutures, but the braided suture is not necessary from the standpoint of its greater tensile strength. Plain surgical gut has certain disadvantages, but it has adequate tensile strength for any demands made on it in muscle surgery. If the twisted silk suture can be lightly impregnated with a bone wax or a paraffin preparation, it has adequate tensile strength for any use or demand, can be of small caliber and has none of the disadvantages common to plain surgical gut. Clinically, it is almost ideal for all situations in which use of nonabsorbable sutures is permissible.

DR. CONRAD BERENS: Dr. Lewis has asked whether we observe encapsulation of the nylon sutures. Yes, we find encapsulation of all the nonabsorbable types of sutures and of similar synthetic resinous material when transplanted into the orbit after enucleation, not only in the human being but also in animals.

The needle does bend easily. However, this property of the needle has an advantage in operations on the inferior oblique muscle. The needle is so easy to bend that it can be bent in any desired arc. Davis and Geck are making a special needle for this work, which will be affixed to blue nylon.

Dr. Post has brought up an important point about the slipping of the knots; as I said, I recently had a case in which the nylon suture had slipped. Slipping of the knot occurred in spite of its being necessary to place two turns in the nylon and then make another knot, and another knot on that. In recent operations I have made a surgeon's knot, passing the ends of the suture backward through the muscle before cutting it. Our experience is the same as Dr. Post's with regard to the braided suture—it slips much less readily; however, in transplanting Tenon's capsule we have found the braided silk suture difficult to use because of the increased coefficient of friction.

Physiologic Factors in Differential Diagnosis of Paralysis of Superior Rectus and Superior Oblique Muscles. DR. FRANCIS HEED ADLER, Philadelphia.

This article was published in full in a previous issue of the ARCHIVES (36: 661 [Dec.] 1946).

DISCUSSION

DR. W. B. LANCASTER, Boston: Duane explained what he called overaction of the inferior oblique muscle as due to paresis of the superior rectus muscle of the opposite eye—an ingenious theory, but not in accordance with the physiologic facts and principles. Bielschowsky explained the observed behavior of the inferior oblique as due to secondary contraction of the antagonist following paresis of the superior oblique of the same eye, a theory which fits the well established pathologic physiology, for example, in cases of palsy of a horizontally acting muscle. Chavasse, accepting the contracture of the inferior oblique muscle as a natural consequence of paresis of the superior oblique, explained the behavior of the superior rectus of the opposite eye as an inhibitory paralysis, due to nonaction of the elevator muscle when the paretic eye is the fixing eye.

Habitual limitation of the movement of a sound eye in the direction in which the palsied eye habitually fixes may result in inhibitional palsy of the sound eye. Not being called on to elevate the eye, it appears to lose the ability to do so; and when elevation is demanded by covering the fixing palsied eye and urging the patient to look up in that direction the eye lags. If the sound eye is the habitually fixing eye, this functional inhibitional palsy does not develop. If the palsied eye is occluded so that the sound eye is made to fixate, it rapidly recovers its ability to look up, thus showing that the paralysis was of a functional inhibitional type.

It is true, also, that in cases of ptosis, in which elevation of the eyeball is never called for, the eyes seem to lose the ability to look up, and one is led to believe that the superior rectus muscles are palsied, as well as the levator muscles of the eyelids. Upward movement of the eyeball has been inhibited so long that the muscles seem paralyzed, but the paralysis is of a functional inhibitional type. It would seem that a Motais operation would be doomed to failure, but I have seen good results in such cases, as others here probably have. I have also seen the upward movement of the eyeball recovered when the ptosis was cured by one of the simpler operations, such as tarsal resection. Orthopedic surgeons recognize inhibitional palsy as one of nature's methods of meeting a special situation.

Duane did not recognize the possibility of inhibitional paralysis, and Dr. Adler has made it clear that this is the true explanation.

Dr. Warren S. Reese, Philadelphia: A simple, but important, ocular sign that illustrates Dr. Adler's statement of the predominant effect of the oblique muscles is seen in cases of palsy of the third nerve and, occasionally, of incomplete external ophthalmoplegia. It consists in torsion of the affected eye, the upper end of the vertical meridian turning inward as the eye attempts to move from above downward. This, of course, indicates preservation of action of the superior oblique and conforms to the physiologic dictate that the superior oblique acts as an intorter when the eye is abducted. In addition to its diagnostic importance, this sign presents an excellent medium of showing to the student the so-called secondary action of a muscle.

Proliferation of Retinal Vessels Associated with Diabetes. Dr. Arthur J. Bedell, Albany, N. Y.

The author discussed and presented photographs of the classic so-called diabetic fundus with recurring hemorrhages, proliferation of retinal vessels and formation of vascular membranes.

Cultivation of Human Tumor in the Anterior Chamber of the Guinea Pig Eye. Dr. Eugene M. Blake, New Haven, Conn.

Dr. H. S. N. Greene, of Yale University, has successfully transplanted various mammalian and human tumors into the anterior chamber of laboratory animals. No immediate reaction follows such transplantation, and it is probable that the tumor stroma dies and degenerates. The parenchymal cells, however, continue to live, obtaining nourishment from the surrounding mediums. When the delayed mild reaction in the iris occurs, the implant consists of essential cancer cells only, which have no species identity.

The author traced the development of human fibrosarcoma transplanted into the anterior chamber of a guinea pig eye. Attention was invited to the possibilities for further research in this field.

DISCUSSION

Dr. Lawrence T. Post, St. Louis: Incidental to work with the thermophore on which my candidate's thesis of 1924 (Thermophore Therapy and Experimental Studies, Tr. Am. Acad. Ophth. **22**: 353-374, 1924) was based, I transferred the so-called Jensen sarcoma into the

anterior chambers of white rats and treated it with the thermophore at 160 C. for one and two minute applications to the cornea. In about 30 per cent of cases the tumor continued to grow; and in most of these cases, if the tumor had not extended too far, the thermophore destroyed the growth. The principle has had practically no therapeutic application, except in a case of Dr. William Luedde's, that of a patient with only one eye, in which many ophthalmologists who saw the patient concurred in the diagnosis of melanotic sarcoma of the anterior segment of the choroid. Since the patient would not consent to removal of the eye, Dr. Luedde used the thermophore and followed the patient for many years thereafter. The last I heard about it the patient still had the eye and the growth had regressed. Further studies with human tissue should be made and different types of therapy tried. However, I do not by any means advocate the use of the thermophore in treatment of intraocular tumors.

DR. BERNARD SAMUELS, New York: I agree with Dr. Blake's theory that those elements in an implanted tumor which represent normal tissue disappear, so that only malignant cells are left to propagate. The slowness with which he observed the infiltrating type grow in the iris was probably due largely to the mechanical resistance offered by the normal stroma to the advance of the proliferating tumor cells. In man, slow growth is characteristic of the infiltrating type of primary malignant melanoma anywhere in the uveal tract. Dr. Blake noted that the pedunculated implants grew rapidly. This was due to the fact that the tumor cells were disposed in a fluid medium, in which the resistance was not so great as in the iris stroma; furthermore, the resistance being equal in all directions, the mass assumed a globular form.

There are but two primary intraocular tumors of great importance—the malignant melanoma and the retinoblastoma.

DR. EUGENE M. BLAKE, New Haven, Conn.: It may be that the anterior chamber can be used to determine the malignancy of a growth. For instance, in a case of sarcoma of the soft palate of a Negro, in which portions of the tumor were implanted in the eyes of guinea pigs, the implants died in every instance, but when, within a few months, metastases occurred in the neck and portions of these were implanted in the anterior chamber, they grew in 100 per cent of cases. It might be possible to divide these tumors into two stages: the stage of dependency, when they are dependent on their host for growth, and the stage of autonomy. When they reach the stage of autonomy, they will grow in the anterior chamber of a foreign host, but apparently they will not do so in the stage of dependency.

Marginal Myotomy: An Analysis of Twenty-Two Cases. DR. GLEN GREGORY GIBSON, Philadelphia.

This article was published in the February 1947 issue of the ARCHIVES, page 175.

DISCUSSION

DR. ARTHUR J. BEDELL, Albany, N. Y.: When I was an intern at Wills Hospital, forty years ago, Dr. S. Lewis Ziegler taught me this operation. After leaving the hospital, I did marginal myotomy for only

a short time and discarded it for the reasons which Dr. Gibson has so well stated.

Penicillin in Treatment of Gonococcic Conjunctivitis. Dr. Philip Meriwether Lewis, Memphis, Tenn.

Over a period of eight and one-third years, 203 patients with gonococcic conjunctivitis were treated at the Isolation Hospital in Memphis. Of these, 123 were treated with sulfonamide compounds, 30 with penicillin and 6 with penicillin and sulfadiazine. In the series treated with penicillin there were no failures, no recurrences and no unfavorable reactions. The penicillin was administered topically, as well as systemically. Dr. Lewis concluded that penicillin is at present the most effective and the most satisfactory agent for the cure of gonococcic infection of the eye.

Plastic Eye Implant. Dr. A. D. Ruedemann, Cleveland.

This author described a new acrylic full eye implant and the technic of implantation. A firm and more nearly permanent attachment is obtained with the use of intermediate muscle plates of tantalum, the plates to be attached to the muscles and then to the plastic globe with tantalum wire. By the use of these plates the eye is retained in the socket. Anesthesia induced with sodium pentothal or solution of tribromoethanol U. S. P. is easier than local anesthesia for the patient.

The implants may be varied in size and shape and can be made available for any type of restoration. Little attachment tissue is necessary, and the ocular conjunctiva is not essential to the implant.

Postoperative infection did not occur in any of the author's 50 cases. There was no postorbital granulation tissue and little tissue reaction.

Dr. Ruedemann concluded that the implantation of a plastic eye is time consuming, painstaking and difficult but that the end results in the appearance of the patient and in the psychologic response justify the effort.

DISCUSSION

Dr. Alan C. Woods, Baltimore: It seems to me that the papers on ocular surgery presented to us fall into two general groups: (1) a large group, which deal with modifications of technic of operations already accepted, and (2) a small group, in which original new procedures are introduced. Dr. Ruedemann's new operation falls into the group of original contributions.

While in Cleveland, I saw a number of patients who had worn these implants for periods of from two days to almost two years. I examined the implants carefully to see whether there was any fading of color or deterioration; I could discover none. I found that the patients, with one accord, were entirely satisfied and were vastly happier than the patient who wears an ordinary prosthesis. I went out to Cleveland somewhat of a doubting Thomas, but I came back converted. After I returned to Baltimore, I made several of these implantations, and other members of the staff followed me and did a number more. The results in the main have been all that Dr. Ruedemann has described. In fact, I believe that when this operation is perfected and the technic finally stabilized the old method of enucleation will become obsolete.

In this operation I should recommend the cautious attitude: Accept it, but realize that there are certain technical difficulties which are not yet fully solved but which, I think, in all probability will be solved. Primarily, tantalum wire is difficult to handle. It has a tendency to kink or break when one is tying knots, and one has to begin again. Assistants must be trained to keep the wire rolling on itself, to catch every suture as the surgeon brings it through and to watch the wire carefully to keep it from kinking. That requires a little practice but can readily be done.

The method of handling the conjunctiva amazed me. Dr. Ruedemann told me that at first he had tucked it in and reenforced it, but finally he just left it, with a lateral suture on each side. I followed this advice and have had no infections or trouble from this source.

There is a great deal left to be desired in the manufacture of these acrylic eyes. Some of the implants we have received have been excellent fits; others have not been so satisfactory. The present method is to measure the eye in the orbit with an ordinary exophthalmometer, take the diameter of the cornea, make a color sketch of the iris and send that information to the American Optical Company. This procedure can probably be improved on.

I have had one complication in a few cases—the first implant was off axis, with a resultant squint. This required a subsequent operation for correction.

This operation is especially adapted for the correction of obliterated sockets. Instead of the old method of using a dental wax implant with a Thiersen graft, one can get almost complete restoration, with a beautiful result, in one operation by shaping up the orbit and implanting an acrylic eye.

Dr. Leslie C. Drews, St. Louis: I should like to ask Dr. Ruedemann whether he has thought of using a number of spikes on these plates, instead of the tantalum wire. He could simply push the spikes through the tendon and bend over the spikes.

Dr. A. D. Ruedemann, Cleveland: I can assure you that the process is not complete, and many improvements will be made. Dr. Woods has already made one.

The problem that Dr. Drews raised has just been studied by Dr. Woods's group; they put a clip on the end of the muscle, so that they do not have to sew it on.

A Device for Group Demonstration of Tests for Astigmatism. Dr. William H. Crisp, Denver.

For the demonstration of tests for astigmatism the author devised a small apparatus to be set up beyond the objective lens of a 35 mm. film projector. The apparatus consists of a carrier, in which may be inserted a simple cylinder at a selected axis, and another cylinder which perfectly, or in varying degrees of imperfection, corrects the astigmatism created by the first cylinder; in front of these cylinders is a fixed metal arm on which can be supported a cross cylinder capable of the same manipulations as are those employed in testing a patient's eyes.

DISCUSSION

DR. JOHN GREEN, St. Louis: Dr. Crisp states that "many refractionists have a relatively feeble notion of what goes on in a patient's brain during tests for astigmatism." I am convinced too, that ignorance of what goes on in the patient's eye during manipulations with the cross cylinder is fairly widespread, despite the clarification of the subject by both Jackson and Crisp.

I am not entirely in agreement with the author's statement that "the nature of the tests with astigmatic dials is easier to apprehend than that of tests with the cross cylinder." This view may be valid when dealing with keen and highly intelligent patients, but with a not too bright patient I have to devote considerable time in attempting to get consistent answers to the query: "Which are the most distinct lines on the chart?"

No one can deny the beauty of Dr. Crisp's device for group instruction. Might it not also be used as a preliminary exercise for patients about to undergo the tests?

I hope Dr. Crisp may develop his device to illustrate pictorially the vagaries and aberrations of the accommodations.

DR. WALTER B. LANCASTER, Boston: I wish to call attention to the fact that most of the methods used are qualitative, and not quantitative. The aberration produced on the letters in the test by a 0.25 D. cylinder is not quantitatively comparable to that produced in the human eye.

In my paper read before the Academy in 1915, I discussed photographing the test objects with a camera made astigmatic, and I should like to show the results.

In the figure, p is the pupil or aperture; r, the retina, the focus of the emmetropic eye; f, the focus when a —0.25 D. cylinder is added, and d, the diffusion circle (line if the cylinder is used) on the retina. The magnitude of the blur depends on three factors: (1) the size of the pupil, (2) the ratio $df : pf$ and (3) the magnification of the image by the lens system.

The distance, in millimeters, of the focus behind the retina when the eye is made hypermetropic by a minus lens is indicated by df, in this case a —0.25 D. cylinder. This distance is calculated as follows: The focal length of the eye when the focus is on the retina may be taken as 22 mm., equivalent to 45.45 D.; when the 0.25 D. cylinder is added, the focal length becomes 22.12 mm., or 45.20 D.; the new focus, therefore, is —0.12 mm. back of the retina, and $df = 0.12$ mm. The ratio of $df : pf$ is 0.12 : 22.12, or 1 : 184.

In the case of the camera, the focal length is 166.7 mm. if a 6 D. lens system is used. When a —0.25 D. cyl. is added, this becomes 5.75 D., or 173.9 mm. The value of df is 173.9 — 166.7, or 7.2; the ratio $df : pf$ is 7.2 : 173.9, or 1 : 24.

Thus, the blur in the eye is 1/184 of the pupillary diameter, 4 mm., which equals 0.021 mm. The blur in the camera is 1/24 of the aperture; if the aperture is 20 mm., the blur equals 0.833 mm. The blur circle (line) is forty times as large in the camera as in the eye, apertures of 20 mm. being taken for the camera and 4 mm. for the eye. How much should one allow for magnification of image? The image size for an object at a given distance depends solely on the distance from the nodal point to the retina or film. In the eye it is 17 mm. from nodal point to

retina; in the camera it is 167 mm. from nodal point to film. Thus, the camera image is ten times as large as the eye image. If one wishes the camera to have a blur circle (or line) comparable to the eye, the blur in the former must be reduced ten times that of the eye instead of forty times. This is readily accomplished by reducing the aperture to one-fourth its former size of 20 mm. With an aperture of 5 mm., the camera with a 6 D. lens system would give images the blur of which would be comparable quantitatively to the blur in an eye with a —0.25 D. cylinder. By a similar calculation, quantitative results could be obtained with a camera with a lens of a different focal length. The same is true of a lantern.

Why not make such a demonstration to an audience or class, so that they may get a correct idea of what a 0.25 D. lens produces in the way of blur?

DR. F. H. VERHOEFF, Boston: Dr. Crisp's apparatus is useful for instructing a group of students who know little about refraction. It would be a difficult matter to construct an apparatus that would simulate the optical defects of the normal human eye. I have never thought it worth while to attempt to do so, for each individual student has an optical apparatus of his own, his eye, which may be used for teaching purposes. If its refraction is normal, one can make it abnormal as desired by means of spheres and cylinders.

DR. W. H. CRISP, Denver: The point that Dr. Lancaster emphasized as to the relatively large aperture in the human eye is an important one.

I have a supplemental note with regard to the apparatus. With a high class anastigmatic lens the effect may show less satisfactorily than with a cheaper outfit. The effect on the projection of certain astigmatic dials is at times almost as paradoxic as that of astigmatic dials on some patients. Used with the letters, however, the apparatus demonstrates some of the difficulties which patients experience in answering questions. Some letters, on account of their shape, are so distorted as to suggest a somewhat different judgment on the part of the patient than other letters; generally speaking, it does not pay to ask the patient to concentrate on a simple letter; it is better to have him base his judgment on the survey of a whole line of letters as distorted by the cross cylinder in its two positions. The demonstration also illustrates the fact that the patient can sometimes make a more definite decision if he is looking at the larger letters, instead of at the smallest letters he is able to read. One also realizes the need for instantaneous reversal of the cross cylinder, without an interval in which the patient can be distracted by the more normal intervening appearance of the letters.

Exophthalmos Caused by Eosinophilic Granuloma of Bone. DR. MAYNARD WHEELER, New York.

An abstract of this paper was published in a previous issue of the ARCHIVES (**35:** 61 [Jan.] 1946).

DISCUSSION

MRS. HELENOR CAMPBELL WILDER, Washington, D. C.: In the Orthopedic Registry at the Army Institute of Pathology there are 44

cases of eosinophilic granuloma of bone. Lesions of the skull were present in 20 cases, and in 5 of these there was a history of ocular disturbance. As far as I know, no definite correlation has been made between the ocular findings and the lesions in the skull.

Indications and Contraindications for Keratoplasty and Keratectomy.

Dr. Ramón Castroviejo, New York.

Keratoplasty and keratectomy are no longer surgical procedures of uncertain results, and a sufficient number of cases have already been studied to determine fairly accurately in which cases these surgical measures will be helpful. The most favorable candidates for keratoplasty are patients with simple central corneal opacities, keratoconus or mild interstitial keratitis. Less favorable subjects for keratoplasty, but still likely to receive considerable improvement in vision are some with corneal dystrophy; shallow, superficial opacities; tear gas burns without vascularization, adherent leukomas, descemetoceles or moderate interstitial keratitis.

Patients who are unfavorable candidates for keratoplasty but who may be partially helped by keratectomy are those with corneal scar extending to the limbus, extensive leukomas, band-shaped opacities, dystrophia adiposa, deep burns of the cornea due to tear gas, extensive tattoo-like corneal opacities caused by explosions and extensive corneal opacities with pannus. Unfavorable for either keratoplasty or keratectomy are patients with corneal opacities in aphakic eyes, Fuchs's epithelial dystrophy, extensive corneal opacities with calcareous degeneration, opacities associated with pemphigus and opacities with extensive anterior synechias. Patients with nystagmus and uncooperative or highstrung patients are unsuitable.

DISCUSSION

Dr. William H. Crisp, Denver: I should be obliged if Dr. Castroviejo would say something about the cases of extreme keratoconus, rarely seen, in which there are great bulging of the cornea and cloudiness of the apex of the extreme cone.

Would Dr. Castroviejo say a little more as to whether one may expect any gain from roentgen treatment of general vascularity from a tear gas burn many years after the accident has occurred?

Dr. F. H. Verhoeff, Boston: I wish to ask Dr. Castroviejo his opinion as to the possibility of recurrence of corneal dystrophy in a graft, and whether in this respect there is any difference in the various types of dystrophy. I know such recurrences have been recorded, and I should like to know whether he thinks its likelihood is great enough to contraindicate keratoplasty.

Dr. Ramón Castroviejo, New York: Dr. Crisp has asked whether an extensive keratoconus is suitable for keratoplasty. If the keratoconus is very extensive but one feels that the whole conus can be replaced by a transplant 6.5 or 7 mm. in diameter, the eye is suitable for keratoplasty. If the conus is so large that in order to replace it a transplant larger than 7 mm. will be required, the operation is likely to be followed by severe complications, such as extensive synechias, leading to secondary glaucoma. In such a case it is advisable to flatten the conus by treating approximately 6 mm. of the center with a fulgurating current applied

with a fine electrolysis needle. After the treatment the eye has to be bandaged with a pressure dressing, which is continued until cicatrization is complete. This treatment causes corneal opacity of the treated area, but the eye is rendered more favorable for keratoplasty when the corneal curvature has been brought within approximately normal limits.

In regard to extensive vascularization of the cornea treated with radiation, my experience has shown that, once the blood vessels have already formed, treatment with roentgen radiation or radium is of no value. Radiation has to be given before the blood vessels have formed. After keratectomy, roentgen treatment is instituted on the same day or on the day after the operation, when the capillaries are beginning to form and they are easily obliterated by radiation. In this way vascularization of the cornea is prevented.

To Dr. Verhoeff's comment on the likelihood of the transplant becoming involved by the cornea of the host affected with dystrophy, it may be said that with some types the dystrophy of the host invariably invades the transplant, such as in Fuchs's dystrophy and dystrophia adiposa corneae. With other dystrophies the transplant is likely to remain transparent.

DR. F. H. VERHOEFF, Boston: There is a recurrence of the same type of growth?

DR. RAMÓN CASTROVIEJO, New York: Yes, in some cases the transplant is partially or totally involved by a dystrophy of the same type as the host's.

Cataract Associated with Intraocular Tumors. DR. BERNARD SAMUELS, New York.

This paper was published in full in a previous issue of the ARCHIVES (**35**: 366 [April] 1946).

DISCUSSION

DR. ALEXANDER E. MACDONALD, Toronto, Canada: I wish merely to call attention to an interesting point on one of the slides—a small area, subcapsular, apparently not lined by membrane, but looking like a bleb. I am much interested in these little "blebs" which are frequently visible with the ophthalmoscope in older patients. These small spherical lenticular spaces can hardly be called cystic, and I am anxious to ask Dr. Samuels whether he could suggest a better term, or would he be satisfied with calling them blebs or edema?

DR. BERNARD SAMUELS, New York: I should not call them either blebs or edema. I should call them pseudocystic spaces.

Intraocular Manifestations of Acute Disseminated Lupus Erythematosus: Report of a Case. DR. FERDINAND L. P. KOCH, New York, and (by invitation) DR. WILLIAM P. MCGUIRE, Winchester, Va.

A case of acute disseminated lupus erythematosus occurring in a 22 year old woman was described. Ophthalmologic examination revealed bilateral retinopathy characterized by numerous superficial retinal hemorrhages, periphlebitis and retinal and choroidal exudates.

The retinopathy became severer as the vasculitis progressed: Normal vascular channels became converted into fibrosed cords; the optic nerve underwent progressive atrophy, and the hemorrhages and exudates gradually decreased. Prior to death, light perception was lost in the right eye and was barely elicitable in the left eye.

The author suggested early and thorough ophthalmoscopic examination in all cases of "fever of unexplained origin."

DISCUSSION

Dr. Henry P. Wagener, Rochester, Minn.: I think that Dr. Koch and Dr. McGuire will agree that at times patients presenting themselves solely because of loss of vision show retinal lesions similar to, if not identical with, the condition they have described. The principal feature of this retinopathy is the perivascular and endovascular inflammatory process which involves the arterioles and veins, though at times only the veins, with resultant apparent occlusion of small vascular branches or of segments of the larger vessels. The ophthalmologist "suspects" tuberculosis, thromboangiitis obliterans, syphilis or focal infection. But often thorough clinical and laboratory investigations reveal no evidence of any of these diseases in other parts of the body. He is forced to content himself with the diagnosis of inflammatory vascular disease of unknown origin confined to the vessels of the eye. When he is fortunate enough to see these retinal lesions in association with a recognizable systemic disease, he is again encouraged to hope that in the future an adequate uniform explanation may be formed for the occurrence of these vascular diseases at times in single, and at other times in disseminated, locations.

Until recently my own experience with retinal changes in cases of disseminated lupus erythematosus had been confined to the lesions described by Maumence and shown by him to be of nonspecific "toxic" character. A few weeks ago I saw a girl aged 8 years with a condition diagnosed as disseminated lupus erythematosus clinically and confirmed at necropsy. At the time of her admission ophthalmoscopic examination revealed in one eye what I interpreted to be an embolic closure of a small peripheral arteriole, with ischemic edema of the corresponding portion of the retina. One day before death there were numerous, apparently embolic, petechiae in each retina with mild edema of the disk and retina similar to the picture seen in subacute bacterial endocarditis. Necropsy revealed definite nonbacterial vegetations on the heart valves. I was unable to secure the eyes for histologic examination.

Dr. Alexander E. MacDonald, Toronto, Canada: Patches of exudate were shown in one of the slides. These patches were definitely white, rather than grayish, and there were no pigmentary disturbances. It seems to me that choroidal exudate sooner or later is accompanied with pigmentary changes. The white exudate appears to be purely retinal, and I should like to ask whether any pigment appeared in these areas later.

Dr. Ferdinand L. P. Koch, New York: It seems a pity that the relatively large number of autopsy reports on this infrequently seen disease have passed over the question of the ophthalmic changes with remarkable uniformity (except for Maumence's report), a fact which is

due primarily, of course, to the lack of understanding that changes in the eyegrounds will occur in this entity.

To answer Dr. MacDonald's question, we do not know whether these exudates were in the choroid or in the retina. Visualization of the fundus in this patient was exceedingly difficult as death approached.

An Accurate Method for Centering a Front Stop (During Refraction Under Cycloplegia). DR. LESLIE C. DREWS, St. Louis.

The author described a simple device for centering front stops of any desired size in retinoscopy or in cycloplegic refraction. Through the exact center of a + 4.00 to + 8.00 thin lens is drilled a hole 4 to 5 mm. in diameter. If the refractionist is to hold the front stop, a crystal lens may be used; but if the patient is to hold it the lens should be made of cobalt blue glass. A method of centering such a stop entoscopically was also described.

DISCUSSION

DR. WALTER B. LANCASTER, Boston: For the problem of the large pupil Dr. Drews has offered a solution which works. A patient of reasonable intelligence can readily center the instrument with the cobalt glass, and the operator himself can center the other one if he works within arm's length. It is possible, therefore, to examine a limited area of the pupil either by retinoscopy or by subjective tests. I have not used this test in actual office practice, but the fact remains that it does solve the problem of how to deal with the dilated pupil when a cycloplegic is used. Not using cycloplegic routinely myself, I seldom am confronted with the problem. I should be glad to show how to do refraction without cycloplegia.

DR. LESLIE C. DREWS, St. Louis: I wish to repeat that I do not think this apparatus is of great use in retinoscopy. I think it is of considerable interest and has possibilities in doing cycloplegic refraction.

Book Reviews

Applied Anatomy of the Head and Neck. By Harry H. Shapiro, D.M.D. Second edition, revised and reset. Price, $10. Pp. 333, with 221 illustrations, 41 in color. Philadelphia: J. B. Lippincott Company, 1947.

This book is especially designed for students and practitioners of dentistry, to relate the anatomy of the head and neck to the various fields of dental work. The anatomic details described are confined to features of most practical significance in diagnosis and treatment in the aforementioned specialty. References to specific cases and applications are interwoven and add greatly to the value of the treatise.

In keeping with the original purpose, the text of the revised edition contains new chapters on the development of the head and neck, the paranasal sinuses, the anatomy of oral infections, and other subjects. The chapters on surface anatomy, interpretation of anatomic landmarks in the roentgenogram of the skull, musculature of the face and jaws and anatomic considerations in maxillofacial war injuries have been enlarged.

The drawings and photographs, some in color, are well reproduced.

The treatise contains material of some value to the ophthalmologist, who not infrequently is called on to express an opinion on a patient's dental problems.

RAYMOND L. PFEIFFER.

Eye Surgery. By H. B. Stallard, M.B.E., M.D., F.R.C.S., Price, $11. Pp. 444, with 338 illustrations. Baltimore: The Williams & Wilkins Company, 1946.

In this informative book, the author sets forth in clear terms his views on most problems of ophthalmic surgery. It is all the more remarkable because it was written during wartime, under the most trying conditions. It is replete with excellent illustrations, most of which were sketched by the author himself. The value of this volume lies largely in its concise portrayal of procedures which have proved useful to this experienced surgeon. As such, it of necessity contains some ideas with which others may disagree, but the vastness of the author's practical knowledge is evidenced by the soundness of his teachings.

The introductory chapter contains much useful information about the layout of an operating room, care of instruments, drugs and preoperative and postoperative care of patients, as well as wise advice to the surgeon and his staff. The second chapter, devoted to anesthesia and analgesia, is followed by an extensive review of plastic procedures. In this section, the author's wide experience with war injuries is given in graphic form, with numerous photographs taken before and after operation, together with a description of the reconstructive methods used. While the discussion contains little that is new or original, many valuable details on suturing, technic and postoperative care are included. In his discussion on ptosis, to the reviewer's surprise, there is no men-

tion of the Dickey operation. The chapter on the lacrimal apparatus contains an account of the usual operations and, in addition, a description of a procedure called "conjunctivo-dacryocystostomy." In this operation the fundus of the freed lacrimal sac is sutured to the edge of a conjunctival incision made in the lacus lacrimalis. The author conservatively concludes this description with these words, "However, in spite of a good opening, drainage of tears is not so satisfactory as through the normal channels."

In the chapter on extraocular muscle surgery, one finds a perpetration of the usual error in referring to removal of a portion of the inferior oblique as a myomectomy, instead of a myectomy. His preference for use of the so-called guarded tenotomy in young children is not generally shared, nor do most surgeons feel it necessary to cover both eyes for eight to ten days after operations on muscles.

In the discussion on keratoplasty, a proper conservative attitude is adopted toward this operation. Castroviejo's technic is that originally described by this author, but one he no longer uses.

The chapters on intraocular surgery include descriptions of the usual procedures, with many interesting personal comments on technic, indications and complications. The corneoscleral suture, for which the author is well known, is described in detail, as is his technic of implantation of radon seeds in the treatment of intraocular neoplasms. In the chapter on traumatic surgery there is an excellent account of the technic employed in extracting an intraocular foreign body by the posterior route. The extreme care with which every detail of each operative procedure is described makes this book a most valuable one for the average ophthalmic surgeon. Its popularity will be justifiably great, for it is lucidly written, well printed and clearly illustrated.

JOHN H. DUNNINGTON, M.D.

Transactions of the American Ophthalmological Society: Eighty-first Annual Meeting, Hot Springs, Va., 1945. Vol. XLIII. Pp. 644. Philadelphia: American Ophthalmological Society, 1945.

These transactions bring a report of the Eighty-First Annual meeting of the American Ophthalmological Society, which was held at Hot Springs, Va., on Nov. 12 to 14, 1945, with Dr. S. Judd Beach, president, in the chair. The meeting of the year 1945 was postponed until the fall, owing to the Government restrictions on railroad travel. Nevertheless, the attendance was unusually large, and the society was honored with the presence of Prof. Ida Mann, of Oxford, England. The scientific program consisted of twenty-three papers. Dr. H. P. Wagener, Rochester, Minn., presented the report of the Committee on the Classification of Hypertensive Diseases of the Retina. A number of new instruments were exhibited, and the theses of 6 successful candidates are added, making in all an imposing volume of 644 pages.

The editor, Dr. Wilfred E. Fry, of Philadelphia, deserves the thanks of the members of the American Ophthalmological Society for this successful volume.

ARNOLD KNAPP.

Transaction of the American Ophthalmological Society. Vol. XLIV. Pp. 554. Philadelphia: American Ophthalmological Society, 1946.

This volume of 554 pages, brings a report of the eighty-second annual meeting of the society, held at San Francisco, June 26 to 28, 1946, under the presidency of Dr. Eugene M. Blake, of New Haven, Conn. Twenty-four papers were presented and discussed. Five new members were elected; their names and the subject of their theses were as follows: Dr. William B. Anderson, Durham, N. C., "Observation on Corneal and Conjunctival Pigmentation Occurring Among Workers Engaged in the Manufacture of Hydroquinone"; Dr. Hugo Bair, Rochester, Minn., "Analysis and Interpretation of Anomalous Localization and Allied Phenomena Associated with Strabismus"; Dr. Harold Gifford, Omaha, "A Study of the Vitreous Pressure in Cataract Surgery"; Dr. David O. Harrington, San Francisco, "The Autonomic Nervous System in Ocular Diseases," and Dr. William P. McGuire, Winchester, Va., "Surgical Correction of Paresis of the Superior Oblique." The volume contained obituaries of Drs. Ellice M. Alger, J. Wilkinson Jervey, Edward Stieren, E. Eugene Holt Jr., Cassius D. Wescott and James Watson White, members who died during the preceding year.

Eighty-two members attended the meeting, and there were many guests. Sir Stewart Duke-Elder, of London, was present and spoke on "Ophthalmology During the War and in the Future." Sir Stewart was elected to honorary membership and received the Howe medal for 1946.

ARNOLD KNAPP.

A Scientific Method of Fitting Contact Glasses. By Philip L. Salvatori. Price, $3.75. Pp. 170, with 86 figures and photographs, 8 in color. Privately printed, 1947.

Mr. Salvatori was trained by Theodore Obrig, but this book is, perhaps intentionally, much more superficial than Obrig's classic work (Obrig, T.: Contact Lenses, ARCH. OPHTH. **28:** 568 [Sept.] 1942). The author is apparently a skilful and experienced technician, and his descriptions of the molding, casting and fitting procedures are aided by excellent photographs and diagrams. The methods discussed are well known, and nothing will be gained by abstracting them here.

It is not easy to determine for what professional level the book is intended. Perhaps the answer may be surmised from the glossary at the end. Here the reader will learn that anterior means "in front of," that medial means "pertaining to the middle" and that an opaque object "does not permit the passage of light." Putting in a contact glass is known as its "insertion," and the reader who wishes to know what taking it out is called has only to look up the word "removal." However, it is not as a literary technician that Mr. Salvatori should be judged, and his laboratory skill is evident enough.

G. M. BRUCE.